Mathematics low achievement in Greece: A multilevel analysis of the Programme for International Student Assessment (PISA) 2012 data

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Abstract: The main aim of the present study was to carry out an in-depth examination of mathematics underperformance in Greece. By applying a binary multilevel model to the PISA 2012 data, this study investigated the factors which were linked to low achievement in mathematics. The multilevel analysis revealed that students' gender, immigration status, self-constructs about mathematics, pre-primary education attendance as well as individual and school mean socioeconomic status (SES) were statistically significant predictors of student low achievement. It was also found that school accounted for a large proportion of the differences between low achievers and non-low achievers, with the final model explaining a great part of these differences. By successfully addressing the research questions, this study has demonstrated evidence that could help educators and policy makers to tackle the massive problem of mathematics underperformance not only in Greece, but also in other countries with similar educational systems.

Keywords: mathematics, low achievement, PISA, Greece, multilevel modelling

Introduction

Lack of basic literacy and numeracy skills is an issue that concerns many educators and policy makers worldwide, because it is a significant barrier for developing new skills, entering labour market and participation in social life (European Commission, 2014). According to the Program for International Student Assessment (PISA), conducted by the Organisation for Economic Co-operation and Development (OECD), nearly one in five 15-year-olds in the OECD member countries does not acquire the basic skills necessary to participate fully in today's society (OECD, 2015a). In addition, more than 20 per cent and 26 per cent of European and USA students, respectively, do not reach the minimum level of skills in reading, mathematics and science (European Commission, 2013c). The European Union (EU) focuses on policies that aim to reduce the share of low achievers in basic skills to less than 15 per cent by 2020, while the Thematic Working Group on Mathematics, Science and Technology is confident that the Member States of the EU can decrease the number of low achievers in these subjects to fewer than 10 per cent of all 15 year-olds by focusing on early diagnosis and policies at student, classroom, school community and educational system level (European Commission, 2011, 2013c).

Especially the issue of competence in mathematics, where there are more students who do not meet the baseline proficiency level (24.2%) than in science (20.3%) or reading (18.8%), has been taken up at the highest policy level due to its importance for personal, academic, career and social success (European Commission, 2011). In mathematics, low performing students cannot identify and carry out routine, obvious procedures and they are incapable of employing basic algorithms, formulas, procedures or conventions to solve problems and interpret results literally (European Commission, 2013c, 2014; OECD, 2014c). Even though the share of low achievers in reading and science has gradually reduced in recent years, this has not happened in mathematics, where this share has grown since 2003 (European Commission, 2014).

The share of low achieving students fluctuates across different countries. Countries such as Finland and Switzerland, which have put great emphasis on education policies that support equity and tackle low performance, have a small share of underperforming students in mathematics (about 12%), in contrast to Greece, where more than 35 per cent of 15-year-old students do not meet the baseline proficiency level in mathematics (level 2) (OECD, 2014c, 2015a). Although policies that could decrease the proportion of low achieving students throughout the EU are of vital importance for educational, social and financial reasons, most of the European countries have not conducted any research or secondary analysis focusing on low achievement in mathematics (European Commission, 2011). Furthermore, most of the available reports referring to low achievement focused on reading literacy and used data from previous PISA waves. To address this deficit, this research focused on a group of students who had the lowest levels of mathematics achievement using the most recent available PISA data (2012) for Greece.

Literature review

Predicting students' performance at school is considered crucial for pupils, educators, policy makers and stakeholders, and therefore, the factors that can be linked to academic achievement have been investigated by many research studies. Apart from individual factors which are undoubtedly important, there are also various aspects related to school that can provide an insight into student academic performance (Areepattamannil, 2014; Chiu, Chow, & Mcbride-Chang, 2007; Gilleece, Cosgrove & Sofroniou, 2010; Lee & Stankov, 2013; Pangeni, 2014). In particular, student and family background characteristics, pupils' self-beliefs, as well as school-related factors, such as the quality of the available school resources, have been shown to demonstrate an understanding of student performance in mathematics (Ashcraft & Krause, 2007; Glewwe et al., 2011; Hyde & Mertz, 2009; Tariq et al., 2013).

Background characteristics

Gender

Even though there are many studies in the worldwide research literature examining the role of gender in educational outcomes, there is still a controversy about the importance of gender for student achievement in mathematics. There are some research studies which have reported a gender gap in favour of boys, even with small differences (Byrnes & Miller, 2007; Fryer & Levitt, 2010). Lindberg et al. (2010), after examining the results of 242 studies conducted between 1990 and 2007, found that even though boys used to outperform girls in mathematics back in the 1990's, this gap has narrowed during the last decade, and therefore, they suggested that there are no longer gender differences in mathematics achievement. In Greece, although gender differences in mathematics have declined, boys still perform much better than girls (OECD, 2014c).

Else-Quest, Hyde & Linn (2010) who conducted a meta-analysis of the PISA and TIMSS (Trends in International Mathematics and Science Study) 2003 results from 69 countries, including Greece, suggested that overall differences between boys and girls were very small. While this may indeed be the case at a general level, a more thorough examination of the results indicates that there are, in fact, some large variations across countries, as evidenced by effect sizes ranging from -0.42 to +0.40 Cohen's d. For this reason, careful consideration should be given to differences between boys and girls across countries.

Finally, as far as low and high mathematics achievement are concerned, the EU report about the PISA results suggested that the share of low achievers in mathematics does not reveal statistically significant gender differences (European Commission, 2013b; 2014). However, there were big differences between European countries possibly emerging from social and educational differences (European Commission, 2014; OECD, 2013b), something suggesting that an in-depth examination of mathematics underperformance should be undertaken at national level. Gilleece et al. (2010) who undertook a secondary analysis of the PISA 2006 data for Ireland, found statistically significant gender differences in low achievement with girls being more likely to underperform in mathematics. In Greece, the PISA 2012 results indicated that 36.9 per cent of girls and 34.5 per cent of boys were low achievers in mathematics (OECD, 2014c). However, it is not possible to draw conclusions about gender differences without taking into account other, potentially important factors, such as students' SES and self-beliefs which are explored in the following sections.

Socioeconomic status

The importance of SES for mathematics performance is supported by many large cross-national studies such as the PISA and TIMSS, where this variable is measured as an index of parents' education and occupation, family wealth and resources available at home (educational and cultural) (Martin et al., 2012; OECD, 2014d). In the TIMSS 2011 assessment, where more than 600,000 students aged between 9 and 14 years old from 63 countries participated, results revealed a strong positive relationship between SES and student performance in mathematics (Martin et al., 2012). This conclusion was also supported, but for a different age group, by the PISA 2012 results, where 15-year-old students from high SES families tended to outperform those from low SES families (OECD, 2013b).

At the EU level, students from socioeconomically disadvantaged families were 2.7 times more likely to be low achievers (European Commission, 2013c). However, percentages revealed that in Greece, the risk of socioeconomically disadvantaged students being low achievers in mathematics is very high, compared to other countries such as Estonia and Finland (European Commission, 2013c; OECD, 2015a). Researchers who conducted multiple regression analysis of student mathematics performance in various countries, such as Japan, Sweden, Singapore, Korea, Taiwan, Hong-Kong and USA, confirmed the importance of SES even after controlling for other independent variables, such as students' gender and origin, school location and teachers' characteristics (Goforth et al., 2014; Hojo & Oshio, 2012).

Further evidence regarding mathematics achievement came from a large-scale survey conducted by Suárez-Álvarez, Fernández-Alonso & Muñiz (2014) with 7729 secondary school students in Spain. By undertaking a multiple regression analysis, this study indicated that although SES was statistically significantly linked to mathematics achievement, attitudinal factors, such as self-concept, impacted mathematics achievement more intensely. Therefore, to better depict the predictive power of SES, the present study examined SES along with other background characteristics such as immigration status (explored in more detail below), self-belief and school-related variables, via a multilevel model.

Immigration status

Low SES is not the only obstacle to equity in education. Indisputably, minorities and immigrants face particular difficulties that educators need to take into consideration (OECD, 2008). At the same time, the percentage of immigrants in the OECD countries is continuously increasing, reaching the 12 per cent in 2012 (OECD, 2013b). Although, the PISA 2012 revealed that immigrant students had improved their mathematics achievement, they still perform statistically significantly worse than non-immigrants (OECD, 2014c). Nevertheless, these differences vary across different countries. At the EU level, immigration status is related to low achievement in mathematics, with foreign students being less likely to acquire the basic knowledge (European Commission, 2013a; 2014). Immigrants tend to be socio-economically disadvantaged, but their SES cannot explain their low performance, since even when comparing students with similar SES, non-immigrant students outperform immigrants, not only in mathematics but also in science and reading (Meunier, 2011; OECD, 2013b).

In Greece, immigration has always been an important phenomenon, with large numbers of immigrants arriving in the country since 1990 (OECD, 2005). In 2012, 11 per cent of students at Greek schools were immigrants, while this share was nine per cent back in 2003 (OECD, 2013b). The gap between immigrant and non-immigrant students in mathematics achievement is above the OECD average, while the share of immigrants at Greek schools is negatively related to student performance even after accounting for individuals' SES (OECD, 2013b). Especially in Greece, where native students tend to have negative attitudes toward their immigrant peers, immigration is a challenging topic for the authorities which have still a long way to go in order to leave behind the ethnocentric system and fully implement intercultural education (Dimakos & Tasiopoulou, 2003; Palaiologou & Faas, 2012).

Pre-primary education attendance

Pre-primary education refers to any form of education provided to children before attending primary schools. The importance of the pre-primary education attendance for children's social and emotional development, learning success and well-being, has been recognised by many studies in the world research literature (OECD, 2013e). Evidence suggests that early childhood education can lead to better learning outcomes possibly because it prepares students for the upcoming primary education (Martin et al., 2012; OECD, 2013e). Recent TIMSS results revealed a very strong positive relationship between pre-primary education and student performance in mathematics and science (Martin et al., 2012). It has been also suggested that even one year or less of pre-primary education attendance was enough to improve mathematics attainment, but this relationship was stronger for students who attended pre-primary schools for more than one and more than three years respectively, supporting the findings of independent research (Martin et al., 2012; Nelson, Westhues & MacLeod, 2003).

These results are in accordance with the PISA 2012 findings from 64 countries and economies, according to which the long-term effects of early childhood education on mathematics achievement are noticeable even after more than 10 years, in 15-year-old students (OECD, 2014b). A longitudinal study conducted in the USA by the National Center for Education Statistics (2009) with almost 4,000 children drew similar conclusions regarding the positive influence of early childhood education on student mathematics and reading performance. Taking into consideration all these up-to-date sources of evidence, the European Commission (2013c, 2014) noted the importance of early childhood education both for addressing low achievement in mathematics and improving equity in education, which is a determinant factor to the achievement of students from disadvantaged backgrounds.

In Greece, the share of 15-year-old students who reported that they had attended pre-primary education for more than one year was considerably lower (68%) than the OECD average (75%) (OECD, 2014a), possibly because of the limited opening hours and the restricted range of services provided to students (Koutsogeorgopoulou, 2009). Moreover, as far as the quality of Greek pre-primary education is concerned, the absence of a central quality assurance programme has intensively affected the quality of these services (Koutsogeorgopoulou, 2009; OECD, 2011). Despite these difficulties, Greek students who had attended pre-primary education for more than one year benefited much more than the average student in the OECD countries, outperforming by 70 score-points in mathematics those who had not received early childhood education services, while the respective OECD average difference was 54 score-points (OECD, 2013b). In the present study, the importance of pre-primary education for avoiding low performance in mathematics was examined in more depth, in combination with other factors linked to student underperformance in mathematics.

Self-constructs

Apart from background characteristics, the research literature has investigated non-cognitive factors, such as students' self-beliefs, motivation and attitudes, in order to explain their mathematics achievement (Lee & Stankov, 2013; Simzar et al., 2015; Yaratan & Kasapoğlu, 2012). Self-efficacy, self-concept, anxiety, engagement in mathematics activities and particular types of motivation to learn mathematics, have been examined by many research studies worldwide and constitute indices of students' motivation and beliefs toward mathematics (Lee & Stankov, 2013; OECD, 2014d; Stankov, 2013; Trowler, 2010). The findings reported in the research literature suggested that, among these factors, mathematics self-efficacy, self-concept and anxiety seem to be the strongest non-cognitive predictors of mathematics attainment (Lee & Stankov, 2013; Lee, 2009; OECD, 2013c) and therefore these self-constructs were examined in more depth for the purposes of the present study.

Mathematics self-concept

Self-concept is the way in which individuals perceive their strengths, weaknesses, skills, attitudes and values (Marsh & Craven, 2006; Marsh et al., 2009). More specifically, mathematics self-concept refers to students' perceptions of their mathematics abilities (Vandecandelaere et al., 2012). PISA defines mathematics self-concept as the extent to which "students' beliefs in their own mathematics abilities" (OECD, 2013e, p. 87). It is well established in the research literature that mathematics self-concept and mathematics achievement are mutually reinforced, since high academic achievement is related to improvements in academic self-concept, but in turn high academic self-concept is also related to improvements in academic achievement (Chen et al., 2013; Guay, Marsh & Boivin, 2003; Marsh, Hau & Kong, 2002; Marsh et al., 2005; Marsh & Köller, 2004; Seaton et al., 2014). Independent measures, such as the PISA mathematics tests, have also confirmed the strength of the relationship between mathematics self-concept and mathematics achievement finding a strong correlation ($r=0.50$) (OECD, 2013c).

Mathematics self-efficacy

The term "self-efficacy" describes pupils' conceptions that, via their actions, they can produce desired effects and it is a powerful motive to act in order to deal with difficulties (Bandura, 1997). In specific, mathematics self-efficacy refers to students' beliefs that they can perform given mathematics tasks successfully (Schunk, 1991). Although there are similarities between the self-constructs "mathematics self-concept" and "mathematics self-efficacy", self-concept is defined as a more general self-confidence term, in contrast to self-efficacy, which reflects students perspectives of whether they are capable of performing specific tasks in mathematics (Morony et al., 2013). Mathematics self-efficacy is defined by PISA as "the extent to which students believe in their own ability to solve specific mathematics tasks" (OECD, 2013e, p. 87).

The positive relationship between mathematics self-efficacy and mathematics achievement (Stankov, 2013), even after accounting for student background or other attitudinal characteristics has been clearly demonstrated by the research literature (Kitsantas, Cheema & Ware, 2011; Lee, 2009). However, the causal direction of this relationship is not clear. Even though, theoretically, better performance leads to higher levels of self-efficacy, the latter seems to be a pre-requisite for success in mathematics, since pupils with low levels of self-efficacy are more likely to be low achievers even if they have acquired the basic mathematical knowledge (Bandura, 1997; Schunk & Pajares, 2009). Consequently, some researchers have suggested that mathematics self-efficacy and student achievement mutually influence each other (Williams & Williams, 2010).

Mathematics anxiety

It is a fact that a large proportion of pupils feel anxious about mathematics (Ashcraft & Ridley, 2005). PISA describes mathematics anxiety as "feelings of helplessness and stress when dealing with mathematics" (OECD, 2013e, p. 87). Students with high levels of mathematics anxiety generally report feeling tense and apprehensive of mathematics (Zeidner & Matthews, 2011). In PISA 2012, across the OECD countries, 59 per cent of students reported that they often worry that it will be difficult for them in mathematics classes, while more than 30 per cent of students reported feeling very tense, very nervous and helpless when doing mathematics problems or generally when they had to do mathematics homework (OECD, 2015b). These percentages are even higher for Greece (OECD, 2013c).

A unanimity is apparent in the literature with regards to the negative relationship between students' mathematics anxiety and mathematics performance (Lee, 2009; Stankov, 2013; Yaratan & Kasapoğlu, 2012). On average across the OECD countries, greater mathematics anxiety is associated with a decrease of 34 score-points in student mathematics performance (OECD, 2013c). Nonetheless, a direct causal relationship between mathematics anxiety and student performance in mathematics cannot be demonstrated by the PISA and other cross-sectional study results since they collect data by producing a "snap-shot" of a population at a particular point in time (Cohen et al., 2011, p. 267). The research studies which sought to establish causality between these two variables were inconclusive. On the one hand, there are authors who suggested that it is high mathematics anxiety that leads to low mathematics achievement (Ma & Xu, 2004; Tobias, 1985), while on the other hand, some research has found that high levels of anxiety can lead to failure in mathematics (Ashcraft & Moore, 2009; Beilock et al., 2004; Hembree, 1990; Hopko et al., 2002).

School-related factors

Based on the PISA data, The European Commission suggested that, in terms of academic performance, the school students attend matters, since school differences explain approximately 40 per cent of students' achievement in mathematics (European Commission, 2013c). In Greece, where students are allocated to schools solely on the basis of residence criteria, social segregations are favoured (Koutsogeorgopoulou, 2009), something that can lead to larger between-school differences. Consequently, school-level variables should be explored to indicate whether they can explain differences in mathematics achievement.

The quantity of resources available at schools (e.g. financial, human and time resources) is a variable examined by many research studies with results revealing a weak and unclear relationship with student mathematics achievement (Glewwe et al., 2011; OECD, 2013d). However, the PISA survey measures not only the quantity but also the quality of school educational resources, which is considered to be very important for student attainment in mathematics as well. Even though the research literature is inconclusive about the role of resources in terms of quantity for educational outcomes, quality of educational resources, as measured by the PISA, was strongly and positively correlated with mathematics achievement ($r=0.51$) (OECD, 2013d). Nevertheless, in Greece, this might not be the case because the government is the primary decision maker, with schools having limited autonomy, something that may be an obstacle to the efficient use of the available resources, even if they are of high quality (Hanushek & Woessmann, 2011; OECD, 2011). Therefore, for the purposes of the present study, the relationship between the quality of educational resources available at school and student mathematics performance was examined within the Greek education system, which is characterised by limited flexibility and low quality of resources, despite the large expenditures in the field of education (OECD, 2011, 2013d).

Evidence from multilevel analyses

Although the studies reported so far shed some light on factors related to mathematics performance, most of them have analysed datasets such as PISA and TIMSS using either simple bivariate analyses or multivariate models, without accounting for the fact that the students have not been selected on a completely random basis. Most large-scale studies in educational research do not select students randomly; rather, researchers select a specific number of schools and test all or some students within these schools (Cohen et al., 2011). Although this approach is economical and closer to education reality, it has an important limitation, which results from the fact that students from the same school tend to be more similar to each other and therefore they may answer questions in a similar way (intra-class correlation) (Cohen et al., 2011; Field, 2013). If the clustered nature of the data is not taken into account, the statistical analysis will lead to biased estimates (Tarling, 2009).

Martins & Veiga (2010) conducted a two-level multilevel analysis (first level: student, second level: school) of the PISA 2003 data separately for 15 EU countries, Greece included. The results of this study indicated that in all 15 countries, SES and gender were statistically significant predictors of mathematics achievement. More specifically, boys and students from high SES families performed better than the rest of the students in the PISA mathematics tests. Similar conclusions were drawn by a research study which applied multilevel analysis on the PISA 2006 data for 15-year-old students in Turkey (Demir, Kiliç & Ünal, 2010).

Regarding the importance of SES at school-level, a three-level multilevel model which analysed the PISA data for 34 countries revealed that school SES, measured as the mean of students' SES in each school, was a much stronger predictor of mathematics achievement than SES at the individual level (Chiu & Klassen, 2010). Anderson et al. (2007) who conducted secondary analyses of the PISA 2000 and 2003 data to suggest ways of handling large-scale assessment datasets reached similar conclusions as far as the school mean SES is concerned. Moreover, the results of the analysis conducted by Chiu & Klassen (2010) indicated that mathematics self-concept was a statistically significant predictor of student performance explaining much of the variance in mathematics achievement.

However, the findings of these research studies examined student performance as a continuous outcome, something that may not be optimal for addressing research and policy questions surrounding low achievement and equity in educational outcomes (Gilleece et al., 2010). Therefore, Gilleece et al. (2010) focused on factors associated with low, medium and high mathematics achievement in Ireland by applying a multilevel model with a categorical outcome variable (low achievers, medium achievers and high achievers). The finding of this study revealed that girls, socioeconomically disadvantaged students and those who attended schools with low mean SES were more likely to be low achievers in mathematics. Regarding the importance of SES at school-level, the multilevel analysis indicated again that school average SES was a much stronger predictor than individual-level SES. Nevertheless, the main drawback of this study was the fact that it used the PISA 2006 data which, in contrast to the last available PISA 2012 data, did not focus on mathematics achievement and therefore important variables such as mathematics self-concept, self-efficacy and anxiety were not available. By using data from the last available PISA wave (2012), which focused primarily on mathematics literacy, the present study examined not only background and school characteristics, but also students' self-beliefs about mathematics and therefore provided a more complete picture of low achievement in mathematics.

Aim and research questions

According to the existing research literature relating to mathematics performance, the main factors that have been shown to predict whether a student is a low achiever in mathematics are gender, immigration status, pre-primary education attendance, mathematics self-efficacy and self-concept, anxiety about mathematics, quality of school educational resources as well as individual and school mean SES. By using these explanatory variables, the present study aimed to carry out an in-depth examination of mathematics low achievement in Greece, via comparing 15-year-old low achievers to non-low achievers based on a secondary analysis of the PISA 2012 data. More specifically this study intended to answer the following research questions:

1. How much of the variance between low achievers and non-low achievers in mathematics is attributed to within and between-school differences respectively?
2. Which factors can statistically significantly predict whether or not a student is a low achiever in mathematics?
3. How much of the between-school variance is explained by the explanatory variables in the final multilevel model?

Research methodology

PISA design

PISA is considered to be "the most comprehensive and rigorous international program to assess student performance and to collect data on student, family and institutional factors" (OECD, 2013a, p. 17). Its primary aim is to provide a context for cross-national comparisons, policy-making decisions and national improvements of educational practices (OECD, 2013b). PISA is a program undertaken by the OECD every three years since 2000 to evaluate student science, mathematics and reading achievement in more than 65 countries and economies worldwide. Each PISA cycle focuses on one of the three domains, despite assessing all of them. In the PISA 2012 survey, mathematics was the domain of focus.

Participants

The sampling procedure for the PISA study is referred to as a two-stage stratified design in each country (OECD, 2012b). At the first stage, schools are sampled systematically with probabilities proportional to school size (number of enrolled 15-year-old students). The sampling of schools is followed by equal probability cluster sampling of students within sampled schools from a list of PISA-eligible students (15-year-olds) at each school. In 2012, approximately 510,000 students completed the assessment, representing a population of about 28 million 15-year-old students in the 65 participating countries and economies. PISA focuses only on 15-year-olds in order to better compare their information and achievement internationally, since these students are approaching the end of compulsory education in most countries (OECD, 2013a, 2014c). Regarding the Greek sample, which is used for the purpose of the present study, 5,125 students from 192 schools participated in the PISA 2012 study, representing more than 100,000 15-year-old pupils in the country.

Measures and Variables

Outcome variable

The outcome variable of the main analysis is a dichotomous one that indicates whether a student was a low achiever in the PISA mathematics tests. PISA uses the term "literacy" which refers to an applicable form of knowledge about real-life situations (Lau, 2009; OECD, 2013a). In PISA 2012, mathematical literacy was defined as:

> An individual's capacity to formulate, employ and interpret mathematics in a variety of contexts. It includes reasoning mathematically and using mathematical concepts, procedures, facts and tools to describe, explain and predict phenomena. It assists individuals to recognise the role that mathematics plays in the world and to make the well-founded judgments and decisions needed by constructive, engaged and reflective citizens (OECD, 2013c, p.25).

The score in the PISA mathematics tests, which reveals students' proficiency in mathematics, constitutes a continuous variable which has been standardised for all OECD countries with a mean (M) of 500 and a standard deviation (SD) of 100. Students' proficiency in mathematics is also presented by a six-level performance scale (below Level 1 is the lowest and Level 6 is the highest) according to their achievement in mathematics tests. Individuals with proficiency within the range of level one or below are considered to be low-achievers. Since the outcome variable of the main analysis indicates whether a student is low achiever or not in mathematics, on the one hand there are students who performed at or below level one (low achievers), while on the other hand there are those who performed above level 1 in mathematics tests (medium and high achievers). According to PISA, low achievers in mathematics can only answer straight forward questions involving familiar contexts where all information is present.

Independent variables

The school and student background questionnaires were constructed to provide information that could explain student performance in the PISA assessment (OECD, 2013a). Some of the items in the questionnaires were designed to be used in analyses as single items (i.e. gender, immigration status and pre-primary education attendance), but most were designed to be combined to form scale variables in order to measure latent constructs that could not be observed directly (i.e. mathematics self-constructs, SES, quality of educational resources). At student-level, gender (Girl), immigration status (Immigrant), pre-primary education attendance (PrePrim), socioeconomic status (StESCS), mathematics self-concept (MathConc), mathematics self-efficacy (MathEf) and mathematics anxiety (MathAnx) are the explanatory variables in the model. School mean socioeconomic status (SchESCS) and quality of school educational resources (SchEduRes) are the school-level explanatory variables of the model.

Data analysis

Multilevel modelling is considered to be the most appropriate analysis based on the clustered nature of the data, since it acknowledges the fact that students are nested within schools by inputting variables in more than one level (Tarling, 2009). For the purposes of the present study, a two-level binary multilevel model was applied. Before the multilevel model, which constitutes the main part of the analysis, some descriptive statistics were applied to provide information about the characteristics of the sample. SPSS 22 and MLwiN 2.32 software are used for the analyses.

Results

Descriptive statistics

Gender, immigration status and pre-primary education attendance

Students' mean score in mathematics was 453 with a standard deviation of 84.13, while approximately 36 per cent of students were low achievers in mathematics. Given the fact that mathematics score was standardised by PISA with a mean of 500 (SD=100) across the OECD countries, students in Greece seemed to perform worse than the OECD average.

As Table 1 shows, more girls than boys in Greece were low achievers in mathematics. Just over ten per cent of students in Greek schools were immigrants and, on average, they performed much worse than non-immigrants. Immigrants had a much larger percentage of low achievers than their native peers. Finally, about two out of three students had attended pre-primary education for more than one year. This group had a higher mean score and a lower percentage of low achievers in mathematics than students who either did not attend pre-primary education at all or attended it for less than one year.

Student self-beliefs

The variables "Mathematics self-efficacy", "Mathematics self-concept" and "Mathematics anxiety" have been standardised by the PISA team with zero mean (SD=1) across the OECD countries. Although on average students in Greece were less efficacious (M=-0.1833, SD=0.9167) and more anxious (M=0.1013, SD=0.8448) about mathematics than the OECD average, they had higher levels of mathematics self-concept (M=0.1013, SD=0.8835). Regarding low achievement in mathematics, as Table 2 shows, on average low achievers had lower levels of mathematics self-efficacy and self-concept and were more anxious about mathematics.

Table 1. Gender, immigration status and pre-primary education

Variable	N (%)	Mean mathematics score (SD)	Percentage of low achievers
Gender			
Boys	2538 (49.5%)	457 (90.01)	34.7%
Girls	2587 (50.5%)	449 (77.76)	37.2%
Immigration status			
Natives	4499 (89.4%)	459 (82.96)	32.7%
Immigrants	532 (10.6%)	409 (76.93)	59.0%
Pre-primary education			
No attendance	234 (4.6%)	395 (87.04)	64.8%
Yes, one year or less	1393 (27.4%)	439 (81.32)	40.2%
Yes, more than one year	3463 (68.0%)	463 (89.30)	31.9%

Table 2. Self-belief differences between low achievers and non-low achievers

Variables	Low achievers' mean (SD)	Non-low achievers' mean (SD)
Mathematics self-efficacy	-0.5995 (0.8613)	-0.0487 (0.8631)
Mathematics self-concept	-0.2922 (0.8170)	0.3205 (0.8423)
Mathematics anxiety	0.4518 (0.7759)	-0.0586 (0.8264)

Table 3. Differences between low achievers and non-low achievers in ESCS and school resources

Variables	Low achievers' mean (SD)	Non-low achievers' mean (SD)
Individual ESCS	-0.4938 (0.9493)	0.1739 (0.9468)
School mean ESCS	-0.3555 (0.5227)	0.0989 (0.4992)
Quality of school educational resources	-0.4052 (0.9796)	-0.3153 (0.9450)

Economic, social and cultural status (ESCS)

For the purposes of the present study, the ESCS was used as an index of students' SES. The mean individual ESCS of the Greek sample was -0.0649 (SD=1.0) suggesting that on average 15-year-old students in Greece had lower ESCS than the OECD average (M=0, SD=1). This was also depicted in the school SES where the mean school ESCS across the 192 Greek schools was -0.0646 (SD=0.5526). As Table 3 shows, on average, low achievers had a much lower ESCS (M=-0.4938, SD=0.9493) than the non-low achievers (M=0.1739, SD=0.9468), while they also attended less socioeconomically advantaged schools (M=-0.3555, SD=0.5227) than the rest of the students (M=0.0989, SD=0.4992).

Quality of school educational resources

On average, Greek schools had lower quality of educational resources (M=-0.3477, SD=0.9585) as measured by the PISA than the OECD average (M=0, SD=1). As Table 3 shows, mathematics low achievers in Greece were found to attend schools with lower quality of educational resources (M=-0.4052, SD=0.9796) than the non-low achievers (M=-0.3153, SD=0.9450). However, it should be mentioned that the percentages presented by the descriptive statistics cannot assume statistically significant differences. Therefore, a multilevel model was applied to indicate the factors that can statistically significantly contribute to the prediction of low achievement in mathematics.

Binary multilevel model

For the purposes of the present study, the multilevel analysis was developed in steps, starting with the simplest model and gradually moving to a more complex model, based on the recommendations made by Hox (2010). The scale variables were standardised by the PISA for the OECD countries, and they were also centred on the grand mean for the purposes of this analysis, as the MLwiN programme designers suggest (Rasbash, Steele, Browne, & Goldstein, 2015).

Step 1: Model without explanatory variables (Null model)

The equation (1) represents the simplest model that allows for school effects on the outcome variable. This null model was calculated to provide information about the amount of between-school variance ($\sigma^2_{u\,0}$). First of all, it was checked whether there are statistically significant differences between schools via the Wald test (Steele, 2009). According to the test statistics, there was strong evidence that the between-school variance [$\sigma^2_{u\,0} = 2.234(0.220)$] was non-zero (p<.001, Chi-Square=102.214, df=1). It should be mentioned that the level-1 variance (within-school differences, e_{ij}) cannot be estimated because in a logistic regression model the variance depends on the mean, which changes according to the values of the explanatory variables (Guo & Zhao, 2000). However, a latent value for eij of 3.29 is assumed by convention (Snijders & Bosker, 2012). Adopting this threshold value, the intra-class correlation (ICC) was:

$$\frac{\text{unexplained between school variance } (\sigma_{u\,0}^2)}{total\ unexplained\ variance} = \frac{2.234}{2.234 + 3.29} = 0.404$$

Thus, 40.4 per cent of the variance was attributed to between-school differences and 59.6 per cent to within-school differences. Practically, this suggests that school played a crucial role in whether a student was a low achiever in mathematics or not.

$$logic\ (\pi_{ij}) = \beta_0 + u_{0j} = \ -0.457(0.118) + \ u_{0j}, \qquad (1)$$

where β_0 is the mean intercept and u_{0j} is the variation of actual school (j) intercepts around that mean intercept, while the value in the brackets reveals the standard (SE) (Tarling, 2009).

Step 2: Adding student-level explanatory variables to model

As the equation (2) reveals, all the level-one explanatory variables included in the model were found to be statistically significant predictors of students' low achievement in mathematics, since the estimated coefficients (b) were more than twice their standard errors (Gelman & Hill, 2007; Steele, 2008). These coefficients are actually the logarithms of the odds (log-odds).

More specifically, girls and immigrant students were more likely to underperform in mathematics, while students from socioeconomically advantaged families were less likely to be low achievers in mathematics. Regarding students' self-constructs related to mathematics, students with lower levels of self-efficacy and self-concept and higher levels of anxiety about mathematics were more likely to be low achievers in mathematics. Finally, pupils who attended pre-primary education either less or more than one year were less likely to underperform in mathematics compared to those who did not attend it at all.

$$logic\ (\pi_{ij}) = -0.330(0.228) + 0.302(0.080)Girl_{ij} - 0.296(0.065)MathConc_{ij} - 0.603(0.074)MathEf_{ij} + 0.469(0.054)MathAnx_{ij} + 0.369(0.133)Immigrant_{ij} - 0.492(0.218)PrePrim(one\ year\ or\ less)_{ij} - 0.655(0.205)PrePrim(more\ than\ 1\ year)_{ij} - 0.315(0.049)StESCS_{ij} + u_{0j} \qquad (2)$$

At this point it should be mentioned that including all these level-one explanatory variables in the binary multilevel model, the between-school variance ($\sigma_{u\,0}^2$) considerably decreased from 2.234 to 1.826. This suggests that much of the variance between schools was attributable to student background and self-belief variables. More specifically, approximately 18 per cent of the level-two variance was explained by the student-level variables in this model. However, Wald statistics revealed that the remaining level-two variance was still significant (p<.001, Chi-Square=85.705, df=1), and therefore, school-level explanatory variables needed to be considered.

Step 3: Adding school-level explanatory variables to the model

Having explored the student-level variables and finding that there was still much unexplained variance at school-level, the next step was to identify whether quality of school education resources and school mean ESCS could explain the between-school remaining differences.

The equation (3) presenting the results of the multilevel analysis shows that the quality of school educational resources was not a statistically significant predictor of whether or not a student is a low achiever in mathematics, since its coefficient (b=-0.125) was not at least double the standard error (SE=0.120). However, school mean ESCS was found to be a statistically significant predictor of the outcome variable with large predictive power, since it had the largest estimated coefficient (b=-1.731) which is almost ten times its standard error (SE=0.189). The negative value of the coefficient practically suggests that students who study at schools with high level of ESCS were less likely to be low achievers in mathematics. As was expected, the entry of this statistically significant predictor caused some changes to the coefficients of the rest explanatory variables. The most intense change was that of the pre-primary education attendance where the differences between students who had not attended pre-primary education and those who had attended it for less than one year turned out to be non-significant.

$$logic\ (\pi_{ij}) = -0.558(0.215) + 0.312(0.080)Girl_{ij} - 0.299(0.065)MathConc_{ij} - 0.596(0.073)MathEf_{ij} + 0.466(0.053)MathAnx_{ij} + 0.347(0.131)Immigrant_{ij} - 0.426(0.217)PrePrim(one\ year\ or\ less)_{ij} - 0.585(0.205)PrePrim(more\ than\ 1\ year)_{ij} - 0.225(0.049)StESCS_{ij} + 0.045(0.096)SchEduRes_{j} - 1.731(0.189)SchESCS_{j} + u_{0j} \quad (3)$$

The inclusion of the school mean ESCS variable in the model led to a further reduction of the unexplained between-school variance from 1.824 to 1.004, suggesting that almost 37 per cent of the between-school differences regarding low achievement in mathematics were explained by the mean ESCS of the school that students attend. However, the Wald test indicated that the remaining school-level variance was still statistically significant (p<.001, Chi-Square=52.894, df=1). This suggests that there were differences between schools in terms of mathematics low achievement which were not explained by the independent variables of this model, but could be explained by other predictors not measured in this study.

Interpretation of the final model

Taking into account all these background, self-belief and school-related variables, the final binary multilevel model explained more than the half (55%) of the level-two variance. Generally, it can be concluded that this binary model had a good fit, since most explanatory variables were statistically significant and they explained a large part of the unexplained variance in the outcome variable. Given that the MLwiN presents only the log-odds, but not the odds ratios of the explanatory variables, the latter were calculated manually so that a better interpretation of the model to be achieved ($odds\ ratio\ =\ e^{log-odds} = 2.7183^{log-odds}$). Negative log-odds (i.e. coefficients) are equivalent to odds ratios less than one, and positive log-odds are equivalent to odds ratios greater than one. The odds ratio is interpretable as an effect size. The closer the odds ratio is to one, the smaller the effect and the further the odds ratio from 1, the more influential the predictor is (Tabachnick & Fidel, 2013).

Table 4 presents the final multilevel model in comparison with the null model as well as the model which included only student-level explanatory variables. According to the odds ratios as formed in the final model, girls were 1.37 times more likely than boys to be low achievers in mathematics. Moreover, first or second generation immigrants were 1.41 times more likely than their native peers to underperform in mathematics. Furthermore, although one year or less of pre-primary education did not make any statistically significant difference, students who had attended pre-primary education for more than one year had 44 per cent less possibilities of being low achievers than students who had not attended it at all.

Regarding self-constructs, students with higher levels of self-efficacy and self-concept and lower levels of anxiety about mathematics were less likely to be low achievers. More specifically, with other variables held constant, the possibility of someone being a low achiever in mathematics would be decreased by 26 and 45 per cent for every extra unit of mathematics self-concept and self-efficacy, respectively. On the other hand, an increase of one unit in the mathematics anxiety index predicted an increase of 59 per cent in the odds of someone being a low achiever.

Table 4: Coefficients and odds ratios of the model explanatory variables

Explanatory variable	Null model		Level 1 Model		Final Model	
	B (SE)	OR	b (SE)	OR	b (SE)	OR
Gender (Girl)	_	_	0.302(0.080)	1.35	0.312(0.081)	1.37
Mathematics self-concept	_	_	-0.296(0.065)	0.74	-0.299(0.065)	0.74
Mathematics self-efficacy	_	_	-0.603(0.074)	0.55	-0.596(0.073)	0.55
Mathematics anxiety	_	_	0.469(0.054)	1.60	0.466(0.053)	1.59
Immigration status (immigrant)	_	_	0.369(0.133)	1.45	0.347(0.131)	1.41
Pre-primary education attendance (One year or less)	_	_	-0.492(0.218)	0.61	-0.426(0.217)*	0.65
Pre-primary education attendance (More than one year)	_	_	-0.655(0.205)	0.52	-0.585(0.205)	0.56
Student ESCS	_	_	-0.315(0.049)	0.73	-0.225(0.049)	0.80
Quality of school educational resources	_	_	_	_	0.045(0.096)	1.05
School mean ESCS	_	_	_	_	-1.731(0.189)	0.18
Between-school unexplained variance (σ^2_{u0})	2.234 (0.220)		1.826 (0.197)		1.004 (0.138)	

* Non statistically significant predictor

Finally, the findings indicated that both individual and school mean ESCS were statistically significant predictors of low achievement in mathematics. With other variables held constant, the possibility of someone being a low achiever would be decreased by 20 and 82 per cent for every extra unit of student ESCS and school ESCS, respectively. This suggests that although individual ESCS was an important explanatory variable of the model, school mean ESCS as a school-level variable had much more predictive power.

Discussion and conclusions

Discussion of the research questions

How much of the variance between low achievers and non-low achievers in mathematics is attributed to within and between-school differences respectively?

The null model indicated that about 40 per cent of the variance was attributed to between-school differences and 60 per cent to within-school differences. This finding is in accordance with the existing research literature which has established that the school where students study can explain a great part of their performance in mathematics test (European Commission, 2013c; Martins & Veiga, 2010).

Which factors can statistically significantly predict whether or not a student is a low achiever in mathematics?

The multilevel model revealed that girls in Greece were more likely than boys to be low achievers in mathematics. This supported the previous research literature which investigated mathematics achievement either as a continuous variable (Byrnes & Miller, 2007; Hampden-Thompson, 2013) or as a categorical variable, putting particular emphasis on low achievement (Gilleece et al., 2010). At educational system level, this finding may suggest that the Greek educational system is characterised by gender inequities in favour of males. Nonetheless, the results of the statistical analysis did not support the conclusion of the European Commission (2013c) according to which, on average, there were no gender differences regarding low achievement in mathematics across the EU countries, possibly because there were big divergences among the different countries.

As far as the role of self-beliefs for predicting low achievement in mathematics is concerned, the analysis revealed that students with higher levels of self-concept and self-efficacy, and lower levels of anxiety about mathematics were statistically significantly less likely to be low achievers. These findings not only confirmed the well-established evidence about the strong relationship between student self-beliefs and mathematics achievement (Chiu & Klassen, 2010; Stankov, 2013), but also gave a clearer picture about the importance of self-constructs for avoiding low performance in mathematics.

The findings of this study indicated that neither students' SES nor other background variables could completely explain immigrants' low mathematics performance. The fact that immigrants were more likely to be low achievers in mathematics than their non-immigrant peers, even after controlling for background, self-construct and school-related variables, may suggest that in Greek education there are social inequities against minorities. This finding is consistent both with the existing research about mathematics achievement (Meunier, 2011; OECD, 2013b) as well as with the conclusions of the Council of the European Union, (2010) and the European Commission (2014) about low achievers in mathematics.

In contrast to the previous research about pre-primary education (Nelson et al., 2003), the present multilevel analysis revealed that less than one year of pre-primary education attendance did not make any statistically significant difference regarding low achievement in mathematics. This finding may suggest that even though the attendance of pre-primary education for less than one year was positively linked to student mathematics performance, when comparing low achievers to the rest of the students and after controlling both for the clustered nature of the data and for the effect of other variables, these students were not less likely to be low achievers in mathematics. However, both the results of the present study and the findings of other research studies agree as far as the importance of the extended pre-primary education attendance is concerned suggesting that more years of pre-primary education were linked to higher achievement in mathematics (Martin et al., 2012; Mullis, Martin, Foy, & Arora, 2012; Nelson et al., 2003). More specifically, students who had attended pre-primary education for more than one year were less likely to underperform in mathematics compared to those who had not attended it at all.

As far as the SES is concerned, the multilevel analysis indicated that both individual and school mean SES were statistically significant predictors of low achievement in mathematics, a finding that supports the well-established evidence of the existing research literature (European Commission, 2013c; 2014; Gilleece et al., 2010). The fact that students from different backgrounds do not have the same possibilities of succeeding in mathematics tests may reveal that the Greek education system is characterised by social inequity. Greek schools seem to enforce social inequities, instead of tackling them, since students who studied at schools with low mean SES were much more likely to underperform in mathematics than their peers who studied at socioeconomically advantaged schools.

Finally, the results of the statistical analysis about the quality of school educational resources revealed that this variable was a non-significant predictor of low mathematics achievement. This finding was in contrast with what the OECD has recommended about the positive role of the quality of educational resources for students' mathematics performance (OECD, 2013d). This is possibly not the case for Greece due to the fact that the Greek educational system is one of the most centralised in Europe, with the lowest level of school autonomy across the OECD countries (OECD, 2015a). The assumption behind this argument is that schools with autonomy can tailor the use of the resources to their local needs, something that barely happens in Greece, even if the available resources are of high quality (European Commission, 2014; OECD, 2011).

According to the statistics of the final binary multilevel model, school mean ESCS, which takes into account the individual socioeconomic profile of the students studying at each school, was the strongest predictor of whether a student is a low achiever in mathematics was the. This variable had the largest coefficient (b=-1.731) which was almost ten times its standard error and explained a great part of the school-level variance. Even though both individual and school mean ESCS were found to be particularly powerful predictors of the outcome variable, the school mean SES variable had much more predictive power than the individual SES, something which is in accordance with the existing research (Anderson et al., 2007; Chiu & Klassen, 2010).

How much of the between-school variance is explained by the explanatory variables in the final multilevel model?

The student and school-level explanatory variables included in the final model led to a remarkable decrease of the between-school unexplained variance. More specifically, the final equation model explained 55 per cent of the school-level unexplained variance, which is also a large part of the total variance of the outcome variable. Although the school mean ESCS was the variable explaining the greatest part of the school-level variance, student-level variables (student background characteristics and self-beliefs) made a large contribution to the decrease of level-two unexplained variance. In practice, this suggests that variables measured at student-level can, up to a point, explain differences between schools regarding low achievement in mathematics because schools are possibly homogeneous in terms of these student-level variables (Muijs, 2012).

Limitations

First of all, the analysis of the PISA data, which are cross-sectional, does not allow causal relationships to be established (Cohen et al., 2011). Additionally, the fact that very poor children, who would possibly have had a very low achievement in mathematics, might not attend school at all (UNICEF, 2001), is another limitation, since the inclusion of these disadvantaged children in the analysis would have possibly influenced the results regarding low achievers. Finally, the fact PISA measures only 15-year-old students' mathematics performance and only data for Greece were analysed should definitely be taken into account in the generalisation of the findings.

Contribution of the present study to the research literature

Despite the fact that the decrease of the share of low achievers in mathematics is at the top of the educational policy agenda (European Commission, 2013c; 2014), robust research studies examining this topic are scarce. By comparing low achievers to the rest of the students the present study has significantly contributed to an in-depth examination of low achievement in mathematics. Moreover, the use of the PISA data was another asset of this study which has grounded its findings on a large and representative sample of 15-year-old pupils in Greece. Furthermore, a detailed examination of underperformance in mathematics was achieved, since the PISA 2012 dataset which was used, focused on mathematics literacy and therefore information regarding students' self-efficacy, self-concept and anxiety about mathematics were also measured and investigated. In terms of the statistical analysis, this study applied the most suitable statistical technique for the clustered nature of the data (i.e. multilevel modelling) so as to provide the highest possible quality of evidence (Field, 2013). Finally, the finding of this study can be applicable not only to Greece, but also to other educational systems which share common characteristics and have similar issues in terms of mathematics low achievement.

Suggestions for future research

Even though the school and student-level variables included in the present binary multilevel model explained more than half of the between-school variance, there were still statistically significant unexplained differences between schools. Therefore, other variables, such as school climate and environment as well as teachers' perspectives, approaches, expectations and attitudes which, according to the research literature, are linked to mathematics achievement should be examined by future studies (Chiu, 2010; Hambrick, 2009; National Mathematics Advisory Panel, 2008; OECD, 2013d; Swedish National Agency for Education, 2009). Although system-level variables were not examined in this study, future research studies may also apply a three-level multilevel model including various countries in order to explore whether country differences in terms of mathematics low achievement can be interpreted with respect to differences in educational systems, policies and practices. Finally, the present study provided valuable information regarding mathematics low achievement based on cross-sectional data, and therefore, causal relationships between variables cannot be assumed. Therefore, future research should consider carrying out Randomised Controlled Trials, which is a rigorous approach to establish controllability, generalisability and causality, as well as longitudinal studies that follow children over time (Cohen et al., 2011), so as to explore whether specific interventions can lead to better mathematics performance and decrease the share of low achievers.

Recommendations

By analysing data regarding a specific school subject (e.g. mathematics), this study can support the policy making process more efficiently than investigating overall achievement trends (European Commission, 2011). It is clear from the evidence reported that there is a substantial need to take seriously and address the mathematics low achievement of 15-year-old pupils in Greece as well as in other countries. Therefore, there are some recommendations based on the findings from the current study in conjunction with existing research literature which may be useful for educators and policy makers in Greece, and indeed in countries with similar educational systems, in order to improve the level of equity in education and tackle mathematics underperformance.

Equity in education is achieved when all individuals, regardless of their personal or social circumstances, such as gender, ethnic origin or family background, reach at least a basic minimum level of skills (OECD, 2012a). However, a major finding of the present study was that the Greek educational system is characterised by gender and social inequities. Therefore, it is recommended that policies aiming to tackle low achievement in mathematics should focus on the promotion of equity in education. The role of school, pre-primary education and students' self-beliefs is determinant for tackling underperformance in mathematics and inequity in education.

Regarding the school which students attend, the results of the present study revealed that its role is crucial for avoiding low achievement in mathematics. Given the fact that Greek schools appear to promote inequity instead of tackling it, consideration should be given to reforms of public school admittance arrangements which may favour socioeconomic segregation by allocating students to schools solely on the basis of residence criteria. Thus, Greek authorities could apply an equal distribution of socioeconomically disadvantaged students to different schools so as to tackle inequity and underperformance in mathematics.

Given that both the existing research literature and the present study highlighted the importance of students' mathematics self-beliefs for low achievement, policy should aim at making students feel more confident and less anxious about mathematics. This could be achieved via promoting students' motivation to learn mathematics in supportive learning environments, where students are encouraged and motivated to discuss their ideas (European Commission, 2011; Mueller, Yankelewitz & Maher, 2011; OECD, 2015c).

As far as the field of pre-primary education is concerned, Greece has a lot of work to do in order both to prevent mathematics low achievement and promote equity. On the basis of the evidence provided by this study, which indicated the importance of the extended pre-primary education attendance, it could be suggested that pre-primary education should be promoted by being compulsory not only for five-year-old children but for four-year-olds as well (OECD, 2011). Nonetheless, the lack of a national framework for setting quality standards for early childhood education influences the quality of the services and has also led to poor infrastructure. Therefore, Greek authorities should consider developing robust frameworks of quality evaluation so as to assure that all children take advantage of quality pre-primary education services, provided by well trained staff, in good working conditions, at the highest level.

Finally, authorities should provide Greek schools with more autonomy so as to tackle underperformance in mathematics. The restriction of the centralisation of the Greek educational system would also facilitate a more efficient use of the huge amount of money that the governments have spent on education over the last years, improving the equal allocation of the available resources at schools. Nevertheless, school autonomy should be accompanied by enhanced accountability, concerning student performance and teacher evaluation, so as to lead to greater educational benefits.

Conclusions

The present study has significantly contributed to an in-depth examination of mathematics underperformance by identifying the factors that can statistically significantly predict whether a student is a low achiever in mathematics. The results of the multilevel model indicated the importance of student background characteristics for the prediction of low achievement, with girls, immigrants and students from socio-economically disadvantaged families being more likely to underperform in mathematics. The statistical analysis also revealed the predictive power of the extended pre-primary education attendance, as well as students' self-beliefs about mathematics which were found to be statistically significantly linked to mathematics low achievement. Finally, school mean SES was found to be the most powerful predictor of low achievement with students studying at socioeconomically disadvantaged schools being much more likely to underperform in mathematics. Generally, it can be concluded that the school which students attended accounted for a large proportion of the differences between low achievers and non-low achievers; however, the final model explained a great part of these differences. By successfully answering the research questions, this study has provided meaningful evidence that could help educators and policy makers to tackle the massive problem of mathematics underperformance not only in Greece, but in other countries as well.

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