



Examining students' achievement in mathematics: A multilevel analysis of the Programme for International Student Assessment (PISA) 2012 data for Greece



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ABSTRACT

The main aim of the present study was to carry out an in-depth examination of 15-year-olds' mathematics performance in Greece. By applying a multilevel model to the Programme for International Student Assessment 2012 data for Greece, this study investigated the factors, both at individual and school level, which were linked to mathematics achievement. The results revealed that gender, pre-primary education, self-beliefs about mathematics and individual and school mean socioeconomic status can statistically significantly predict students' mathematics achievement. The analysis also indicated the importance of the school which students attend in shaping their mathematics performance. Generally, it could be concluded that background characteristics, self-constructs and school level variables can explain a large proportion of the variance in students' mathematic achievement.

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1. Introduction

Given that the world is becoming progressively “quantified”, mathematics constitutes one of the key competencies for personal fulfilment and participation in the school, society and labour market of the 21st century (European Commission, 2011). Nevertheless, in Greece, 36% of students do not acquire the basic skills in mathematics, while, on average in the European Union (EU) countries, this percentage is much lower (24.2%) (European Commission, 2014). Improving educational outcomes is of major importance to enhance both productivity and living standards (Hanushek & Woessmann, 2010). Additionally, it could consequently allow Greece to realise its potentials during this harsh period of the economic crisis, and address issues such as unemployment and inequity in education (Hanushek & Woessmann, 2010; OECD, 2013b, 2015b). Indisputably, improvements in academic skills cannot be achieved by simply increasing expenditures for educational purposes, but an in-depth examination of this discipline and careful policy design are required. However, studies examining mathematics achievement in the Greek context are scarce, and therefore, there is a lack of robust evidence about factors that can be associated with students' mathematics achievement.

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2. Literature review

Factors that can predict academic achievement have been investigated by many research studies, provided that educators, policy makers and stakeholders put great emphasis on students' performance at school. Careful examination of both individual and school related factors could provide an insight into student academic performance (Chiu, Chow, & McBride-Chang, 2007; Gilleece, Cosgrove, & Sofroniou, 2010; Lee & Stankov, 2013; Pangen, 2014). In particular, student and family background characteristics, students' self-beliefs, as well as school related factors, such as school socioeconomic status, have been shown to demonstrate an understanding of student performance in mathematics (Ashcraft & Krause, 2007; Hyde & Mertz, 2009; Tariq, Qualter, Roberts, Appleby, & Barnes, 2013).

2.1. Background characteristics

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. Lindberg, Hyde, Petersen, & Linn (2010), who examined the results of 242 studies conducted between 1990 and 2007, suggested that although boys used to outperform girls in mathematics back in the 1990s, this gap has narrowed during the last decade, and they concluded that there are no longer gender differences in mathematics achievement. The finding of a meta-analysis of the PISA and Trends in International Mathematics and Science Study (TIMSS) 2003 data from 69 countries, including Greece, suggested that overall differences between boys and girls were very small as well.

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 (note that positive values of d represent higher scores for males than females, whereas negative values represent higher scores for females) (Else-Quest, Hyde, & Linn, 2010). Therefore, careful consideration should be given to differences between boys and girls across countries. Greece was among the countries where the gender gap narrowed significantly (by 11 points) in 2012 since 2003, but boys still statistically significantly outperformed girls in mathematics (OECD, 2014b). Multilevel analyses, indicated gender differences in favour of boys even after accounting for other variables such as students' economic, social and cultural status (ESCS) measured as an index of parents' education and occupation, family wealth and resources available at home (Hampden-Thompson, 2013; Martins & Veiga, 2010; OECD, 2014c).

The results of the above mentioned multilevel studies also revealed that ESCS was a significant predictor of mathematics achievement, with students from high ESCS families performing better than the rest of the students in the PISA mathematics tests. Generally, there is an unanimity in the world research literature about the positive relationship between students' socioeconomic status and their performance not only in mathematics but in other subjects as well (Hattie, 2009; Martin, Mullis, Foy, & Stanco, 2012; Mullis, Martin, Foy, & Arora, 2012). Moreover, some research studies investigated ESCS at the school level, measured as the mean of students' ESCS in each school (Anderson, Lin, Treagust, Ross, & Yore, 2007; Chiu & Klassen, 2010). The results of these studies indicated that school mean ESCS was a much stronger predictor of mathematics achievement than socioeconomic status at the individual level.

Nevertheless, the performance gap between students from socioeconomically advantaged and disadvantaged families 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). Although, the PISA 2012 results revealed that immigrant students improved their mathematics achievement, they still perform statistically significantly worse than non-immigrants (OECD, 2014b). Immigration has always been an important phenomenon in Greece, where large numbers of immigrants have been arriving since 1990 (OECD, 2005). In 2012, 11% of students at Greek schools were immigrants, while this share was nine% back in 2003 (OECD, 2013b). The difference between immigrant and non-immigrant students in mathematics achievement in Greece is above the OECD average, while the share of immigrants at Greek schools is negatively related to student performance even after accounting for individuals' socioeconomic status (OECD, 2013b). Especially in Greece, with native students having 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 the ethnocentric system behind and fully implement intercultural education (Dimakos & Tasiopoulou, 2003; Palaiologou & Faas, 2012).

Finally, there is a growing body of research literature that recognises the importance of early childhood education, as any form of education provided to pre-primary children, for children's social and emotional development, learning success and well-being (OECD, 2013e). The results of the existing research for different countries suggested that pre-primary education attendance is strongly linked to mathematics achievement and is often seen to contribute to better and more equitable student outcomes, being determinant to the achievement of students from disadvantaged backgrounds (European Commission, 2014). Even one year or less of pre-primary education attendance was enough to improve mathematics attainment, but this relationship was found to be stronger for students who attended pre-primary schools for more than one and more than three years, respectively (Mullis et al., 2012; OECD, 2014a).

2.2. Self-constructs

Apart from the background characteristics, there are other factors related to student achievement in mathematics as well. Some of these factors are students' self-beliefs, motivation to learn and attitudes toward mathematics (Lee & Stankov, 2013;

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