

GREEK AND PORTUGUESE MATHEMATICS EDUCATION AND PERFORMANCE, THROUGH THE PRISM OF PISA

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Abstract

Greece and Portugal are two Southern European countries, with nearly the same population as well as a centralized educational system that follows the same vertical structure. Both countries were deeply affected by the economic crisis during the last decade. Despite being severely hit by the economic crisis, Portugal has advanced to the OECD average level in students' mathematical performance in the Programme for International Student Assessment (PISA 2018), while Greece has performed below the OECD average. PISA, as one of the most influential international educational surveys, aims to evaluate educational systems and provides a valuable platform for comparisons. Portuguese students outperformed their Greek counterparts by 7 points in the first PISA 2000 and went on to widen the difference by 41 points in PISA 2018. In addition to having increased the average performance in Mathematics, Portugal has managed to reduce the percentage of low-achieving students and at the same time increase the percentage of high-achieving students. According to PISA 2018 reports, Portugal is the only member of OECD that has experienced significant improvement in mathematics performance of their students through its participation in PISA. In contrast, the performance of Greek 15-year-old students in mathematics has not improved and has remained below the OECD average since it participated in PISA. What national strategies have been set up and implemented in Portugal so as to foster student's mathematical literacy competencies? A clear curriculum, students' regular assessment, teachers' training and the Action Plan for Mathematics. But despite that fact, the Mathematics performance of Greek 15-year-olds students in PISA in all cycles of PISA remains below the respective OECD average, in contrast with Portugal, that has registered a quantum leap (Crato, 2020).

The main aim of this research is, through a recording of the Greek and Portuguese students' mathematics achievements in PISA and at the same time of the Mathematics Education in both countries, through available policy documents and research reports, to comment on the current outcomes of the two educational systems and their students' performance in Mathematics.

Keywords: *Mathematics education, mathematics achievement, PISA, Greece, Portugal.*

1. Introduction

One of the key competences necessary for personal fulfillment, active citizenship, social inclusion and employability in the knowledge society of the 21st century, is the mathematical competence (European Commission, 2011). Therefore, an understanding of mathematics is recognized by OECD as pivotal to a young person's preparedness for life in modern society and through the Programme for International Student Assessment (PISA), it measures the achievement of 15-years old students on mathematical literacy which is 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 recognize 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, 2014).

The inter temporal importance of PISA can also be located to the point that it has changed the philosophy of world educational policies, by giving feedback to policy-makers to reevaluate their educational system. That's exactly what happened in Portugal, starting from 2001 when the results of first PISA 2000 were published and were disappointing for Portuguese students. It was then that policymakers started to set the stage for the endorsement of a series of ongoing education measures by placing great importance on mathematical education (Marôco, 2021). Furthermore, in Greece, according to Breakspear's (2012) survey, "PISA has provided policy-makers with useful information and tools to

improve the quality and efficiency of the existing education system in Greece". Nevertheless, the Mathematics performance of Greek 15-year-olds students in PISA in all cycles of PISA remains stable and below the respective OECD average, in contrast with Portugal, that has taken a quantum leap (Crato, 2020).

Below we will develop the major educational policies of both Greece and Portugal, regarding mathematics education, which has taken place in the last 2 decades which are explicitly justified or supported by PISA outcomes in both countries.

2. PISA and mathematics performance

Greece's mean performance in Mathematics has been below the OECD average in every year it participated in PISA and can be described as hump-shaped, mainly due to a spike in performance in PISA 2009 while the performance in all other years was stable (OECD, 2019). On the other hand, Portuguese's students mean performance in Mathematics has improved since 2000, 2003 and 2006 while mean performance in 2018¹ was close to the level observed over the period 2009-2015 and is placed above the OECD average. The average 3-year trend in mathematics mean performance in Greece is only +0.1 points while in Portugal it is +6 points. In the latest PISA 2018, the difference of 41 points between the two countries' mean scores in Mathematics, corresponds to one whole school year, since the OECD has calculated that the 38 points correspond to one school year.

Results from PISA 2018 also showed that the share of Greek low achievers in Mathematics, those who scored below Level 2, remains among the highest in the EU with a shrinkage of 3.1 percentage points since 2003 while the share of students performing at or above proficiency Level 5 has also decreased by 0.3 percentage points since 2003. However, in contrast to Portugal, both low and high achieving students have significantly improved their scores and the corresponding share of students who scored below Level 2 in mathematics has shrank by 6.8 percentage points since 2003 while the share of students performing at or above proficiency Level 5 has increased by 6.2 percentage points. More specific in 2018, more than one-third of Greek 15-year-olds participating in PISA were low achievers in Mathematics (35.8% compared to an OECD average of 22.2%) while in Portugal they were less than one-fourth (23.3%). The highest Levels 5 and 6, were reached only by the 3.7% of Greek students as compared to the OECD average of 11.4% and to the Portuguese corresponding average of 11.6%. Girls' and boys' performance is also remarkable because in Portugal boys outperformed girls in by 9 score points (OECD average: 5 score points) whereas in Greece there was no difference in Mathematics score-points between genders. This, however, is due to the reduction of boys' performance and not to the improvement of girls (OECD, 2019).

3. Mathematics curriculum

In both countries, curriculum is defined centrally. The latest revision and update of the mathematics curriculum for primary and lower secondary education in Greece was in 2003 with the single cross thematic curriculum framework (DEPPS) and the detailed curricula (APS) and in comparison, to Portugal's curriculum that was introduced on 2008, both countries' mathematics curricula are similarly more focused on cross-curricular links and the interaction of mathematics with philosophy, science and technology (European Commission, 2011). A revision of this Portuguese curriculum for Mathematics of the second cycle of primary and lower secondary education took place in 2012/13 with the aim of setting learning standards of basic skills to be reached by all students and to give more flexibility over curriculum management (OECD, 2014). A more flexible curriculum in Portugal has also sprung from a pilot programme in 2017/18 and has been in effect since 2018 (EC/EACEA/Eurydice, 2021b).

The poor alignment of Greek Mathematics curriculum in lower secondary school with the PISA's assessment Mathematics framework and the strong content focus (Breakspear, 2012; OECD, 2018) are highlighted through an IEP's survey which showed that in Greek curriculum, Mathematics applications appear as consequences and not as fields within which Mathematics emerged, like happens in PISA (IEP, 2019). The problem solving in Greek curriculum appears as an application of a specific theory and not as a real-life problem which has an invisible or a subtle connection with the "theory", as encountered in PISA's mathematical literacy problems (IEP, 2019).

¹In PISA 2018 it was required that at least 80% of the students chosen within participating schools participated themselves and this percentage was not met by Portugal, where only 76% of students who were sampled actually participated. But, through a non-response analysis based on data from a national mathematics assessment in the country it was shown that the upward bias of Portugal's overall results was likely small enough to preserve comparability over time and with other countries. As a result, the data from Portugal were therefore reported along with data from the countries/economies that met this 80% student-participation threshold (OECD, 2019).

An important proxy that helps to explain the relative importance of Mathematics as a school subject, compared to others in the curriculum is the recommended taught time which means the curriculum time allocated for teaching mathematics (European Commission, 2011). According to last decades' annual European reports, the weight of mathematics in the curriculum of primary education in Portugal was placed in the highest rank among the European countries and Greece was in the lowest. Moreover, in Greece a student who completes primary school has been taught less than half the number of hours of mathematics in total than his Portuguese counterpart (European Commission/EACEA/Eurydice, 2018). In lower secondary education, Greece is between the European countries with the fewest number of hours but with not so wide gap with Portugal (European Commission/EACEA/Eurydice, 2018; 2011). According to student's responses in PISA 2018, the learning time per week in regular mathematics lessons calculated at 3.4 hours for Greece and 4.5 hours in Portugal (OECD average hours 3.7) (OECD, 2019).

The textbooks, being a central tool for the implementation of the Mathematics curriculum, in Portugal are chosen from the teachers among all available textbooks previously approved by the Ministry of Education, while in Greece schools are limited to one specific authorized mathematics textbook that has been approved by the Institute of Educational Policy (IEP) and is the same for all students attending the same grade (EC/EACEA/Eurydice, 2021). The Greek Mathematics textbooks in lower secondary school, according to an IEP's (2019) survey, contain low percentage of real-life math problems whilst the majority of them could be described as "standard" word problems, which can be solved with any combination of arithmetic operations, rather than "problematic" ones which can be compared to the PISA mathematical literacy problems, according to Verchaffel, Greer and De Corte classification.

4. Assessment in mathematics

Student assessment in mathematics is a crucial element of the teaching and learning process and national tests in mathematics are widely implemented and used to inform or guide policymakers to support equity and quality of student learning (European Commission, 2011; OECD, 2018). After Portugal was affected by the poor PISA results, the low-stakes were promoted in 2003 and the corresponding high-stakes exams for Mathematics at the end of Grade 9 were used in 2005 (Marôco, 2021). The application was also expanded (2012) to grades 4 and 6 (OECD, 2014) but was terminated in 2016 (Santiago et al., 2012). Today, student assessment includes both internal and external national assessment in Portugal. The internal student summative assessment is organized by the schools while the external one is carried out by the Educational Evaluation Institute (IAVE) and involves national final exams in the end of basic education cycle, Grade 9, in the subjects of Mathematics and Portuguese, whereas in Grades 2, 5 and 8 standardized tests are administered. There are also national examinations in the end of general secondary education (Liebowitz et al., 2018; OECD, 2020; EC/EACEA/Eurydice, 2021b).

In contrast to Portugal, the Greek educational system has no national assessments in Mathematics to track student performance comparatively across schools, at a regional or national level, either in primary or lower secondary education. The only high-stake national assessment which takes place in Greek educational system is the Panhellenic university admissions examination which is administered only at the end of upper secondary education. In lower and upper secondary school, written progression and school leaving examinations are administered on a number of subjects, as is the case with exams in Mathematics, which are performed by each school and their respective Mathematics' teachers (EC/EACEA/Eurydice, 2021a). It was only as far back as in 2013 that efforts were made to create a more national approach to student assessment in selected school subjects, including Mathematics, in upper secondary school (in Grades 10 and 11) with national tests banks including question items at different levels of difficulty. The use of these test banks was abandoned in 2015/16, given concerns about equity and early school leaving (OECD, 2018).

In Portugal the research work of Marôco and Lourenço, has shown the concurrent and content validity of PISA with the national high-stake exams for mathematics (Marôco, 2020; Crato, 2021). In Greece, due to the absence of national student assessment it is difficult to conduct such surveys. IEP (2019), through some data from the promotion and school-leaving mathematics examinations in 9th grade which were delivered from individual schools and teachers of Mathematics during the last decade, it was estimated that from 232 such tests only on 5 (2%) included at least one item of real-life problem, that could be compared to PISA mathematical literacy problems. So due to the absence of national standardized assessments in Mathematics to provide regular information about students learning outcomes (OECD, 2020) PISA results in Mathematics and data could be provide some evidence to this direction or an international overview of student's performance in relation to other OECD and European countries in order to develop a higher-quality and more equitable Mathematics education (OECD, 2018).

5. Improving student's motivation in mathematics

“Motivation and engagement can be regarded as the driving forces behind learning. Given the importance of mathematics for students' future lives, school systems need to ensure that students have not only the knowledge that is necessary to continue learning mathematics beyond formal schooling, but also the interest and motivation that will make them want to do so” (OECD, 2014). As it is also referred on “PISA in Focus” (OECD, 2014), students who are highly motivated to learn mathematics because they believe it will help them later on score better in mathematics – by the equivalent of half a year of schooling – than students who are not highly motivated or it can be one of the most important determinants of students' achievements in school (European Commission, 2011).

In order to improve student motivation and encourage positive attitudes towards mathematics learning and education, Portugal implemented the “Action Plan for Mathematics”, which was launched in 2005. The six components of the plan were: a) implementing a mathematics plan in each school, b) training teachers in basic and secondary schools, c) reinforcing mathematics in initial teacher training, d) readjusting the mathematics curriculum throughout the compulsory education system, e) creating a resource bank or database specifically devoted to mathematics and f) evaluating textbooks on mathematics (OECD, 2013). The Action Plan is referred that “allows students to dedicate more time to the study of mathematics and focus on exploration, investigation and problem-solving” (European Commission, 2011).

In Greece there are no such national strategies or initiatives (European Commission, 2011).

6. Education and professional development of mathematics teachers

In Greece both primary teachers and secondary education teachers who teach Mathematics hold at least a first cycle degree (UNESCO, 2015; OECD, 2018) and no additional degrees or pedagogical training certificates are required. In Portugal, with the implementation of the Bologna process (finalized in 2009/2010) the minimum requirement for teaching is a second cycle degree, a master's degree, and the preparation of secondary education mathematics teachers which includes components concerning mathematics, general education, didactics of mathematics and a period of teaching practice (Ponte et al., 2017). In all six grades of primary school in Greece and in the first four grades of basic education in Portugal, Mathematics are being taught from teachers who teach the majority of the subjects but in Grades 5 to 6 in Portugal, Mathematics is being taught by teachers who are qualified in mathematics and may be in other subjects as well. In secondary education, lower and upper, in both countries, Mathematics is being taught by a single teacher with a qualification to this subject only.

The focus on Mathematics teachers training could be regarded also as a measure responsible for the improvement of Portuguese 15-year-old students in Mathematics (European Commission, 2011). Through the “Action Plan of Mathematics”, the training of teachers in both primary and secondary education, collaboration between them and co-teaching in the classroom were developed. Also, in measures like “Teams for Success”, schools received support teachers, specialists in Mathematics teaching, to help them implement innovative three-year projects focused on the improvement of students' mathematics learning, the promotion of professional development programmes, the creation of database of educational mathematics resources, the reorganization of initial teacher training programmes and access to STEAM teaching (Kearney, 2011). In additional, at the end of the school year, every school carried out self-evaluation within the scope of the Mathematics Plan II which included an evaluation of the strategies implemented, student performance in mathematics, and the development and implementation of the mathematics programme (European Commission, 2011).

7. Conclusion

The improvement of the level of students' motivation in Mathematics classrooms, the focus on Mathematic teachers' training that laid emphasis into their collaboration and the implementation of national tests in mathematics in compulsory education, with the scope to inform the policy makers for the curriculum development as well as the improvement in teachers training, could be considered as factors positively related to the performance of Portuguese students in PISA Mathematics. A positive conclusion that can be drawn, as demonstrated by the experience of Portuguese Education system and could prove useful to Greek education as well, is that top performers can be nurtured while simultaneously assisting struggling students, thus strengthening the OECD view that “*Countries do not have to choose between nurturing excellence in Education and reducing underperformance*” (OECD, 2016).

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