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The effect of educational systems on differences in the performance of children of different backgrounds and on the improvement of their learning outcomes, with reference to Cyprus

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Abstract

Socioeconomic inequalities in education are an important issue for both researchers and policymakers, since student achievement was found to be associated with students' socioeconomic status (SES). Consequently, educational effectiveness research attempts to investigate not only factors associated with student learning outcomes (i.e., the quality dimension of effectiveness), but also whether effective schools can reduce the initial differences observed in student achievement which can be attributed to student background characteristics that are unlikely to change (i.e., the equity dimension of effectiveness). This report aims to explore the relationship between these two dimensions of effectiveness at the school and country level. To achieve this aim, secondary analyses of data from PISA 2015 and 2018 are conducted. Specifically, we first investigate whether variables associated with economic prosperity (such as SES, GDP and GNI) can explain differences in student learning outcomes. Then, we explore whether educational systems which appear effective in relation to quality are also effective in relation to the equity dimension of effectiveness. Subsequently, we examine whether an improvement in the effectiveness status of countries in relation to one dimension can lead to the improvement of the other dimension. Through within-country analyses, the relation between the two dimensions of educational effectiveness at the school level in Cyprus is examined. The results show that GDP has a significant effect on student achievement in each subject (Mathematics, Science, and Reading), therefore educational systems should control for this effect when establishing policies for promoting equity in education. The findings of this study also reveal a strong relationship between quality and equity at both the country and the school level. The across country analyses showed that the achievement gap (in Mathematics, Science, and Reading) based on SES tends to be smaller in countries and schools which achieve better learning outcomes. It is also shown that the great majority of countries that can be considered as among the most effective in terms of the quality dimension are also among the most effective in terms of the equity dimension. As regards the relationship between the two dimensions of effectiveness at the school level in Cyprus, the great majority of the schools that can be considered as among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension. The implications of the findings for promoting quality and equity are drawn.

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1. Introduction

Education is essential in defining the course of an individual's life since it is associated not only with higher income, but also with better health. Research has shown that school failure has a negative long-lasting impact on a child's life. The child who leaves school without qualifications faces poorer job prospects and lower income throughout his/her working life (Micklewright and Schnepf 2007). The same child is also less likely to take advantage of further learning opportunities and may be less able to participate on an equal basis in the civic and social aspects of modern society. Consequently, educational failure imposes very high costs on society. For example, on the basis of data from the Program for International Student Assessment (PISA), it is estimated that if all 15-year-olds in the area of the Organization for Economic Co-operation and Development (OECD) attained at least Level 2 in the PISA Mathematics assessment, they would contribute over USD 200 trillion in additional economic output over their working lives (OECD 2010a). There are also studies which show that many economic and social problems, such as teenage pregnancy and unhealthy habits, are associated with low levels of educational attainment and skills (Cunha and Heckman 2009; Heckman 2008). The social and economic costs of school failure are extremely high and take many different forms: increased criminality, lower rates of economic growth, lower intergenerational effects on children and parents, higher public health spending, higher unemployment, lower social cohesion (Psacharopoulos 2007), and even lower participation in civic and political activities (Torney-Purta et al. 2001).

For all the above reasons, reducing school failure is seen as a major priority for policymakers around the word. However, school failure is consistently reported in the results of international large-scale studies such as the Trends in International Mathematics and Science Study (TIMSS) and PISA. It is also pointed out that there is a positive relationship between schools with fewer students from economically disadvantaged homes and higher Mathematics achievement (Mullis et al. 2008; OECD 2010b), whereas disadvantaged schools seem to perform less well than the national average performance (OECD 2016). Evidence also shows that children from the poorest homes are more likely to have worse school results and to drop out of school more frequently than children coming from better-off families. Meta-analyses of national studies have also revealed that the socioeconomic status (SES) of students has a strong impact on student achievement (Sirin 2005; White 1982).

Consequently, socioeconomic inequalities in education constitute an important issue for both researchers and policymakers (Marks et al. 2006), since student learning outcomes are also affected by factors deriving from student background characteristics, such as their family's SES, that is not likely to change (Schmidt et al. 2015). For more than 30 years, educational effectiveness research (EER) placed almost exclusive emphasis on the search for factors that may affect student learning progress and academic outcomes (i.e., the quality dimension of effectiveness). However, during the last decade, researchers within the field of EER propose another dimension of effectiveness, namely equity (Kelly 2012; Kyriakides et al. 2018) and attempt to find out whether effective schools can reduce the initial differences observed in student outcomes which can be attributed to student background factors that are unlikely to change (e.g., Charalambous et al. 2018; Kelly 2012; Kyriakides et al. 2019). Given the rapid changes in the composition of student

populations in many educational systems, mostly deriving from changes in social and economic conditions around the world and the constant flow of students coming from disadvantaged and migrant backgrounds, the importance of examining the effectiveness of educational systems in terms of their ability to promote not only *quality* (maximizing possible learning outcomes for all students), but also *equity* (closing the achievement gap between students with regard to their socioeconomic background), is even more evident (Blömeke et al. 2011; Chapman et al. 2012; Lafontaine et al. 2015; Sammons et al. 2018).

The purpose of this study is to investigate the relationship between the dimension of quality and the dimension of equity both at the level of the educational system and at the school level and draw policy implications for promoting equity in education. Specifically, the aims of this study are to examine:

1) The extent to which variables associated with economic prosperity (SES, GDP and GNI) can explain differences in student learning outcomes and also explain why some countries have better learning outcomes than others.
2) Whether educational systems which appear effective in relation to quality are also effective in relation to the equity dimension of effectiveness.
3) Whether changes in the effectiveness of countries in relation to the dimension of equity can lead to the improvement of student learning outcomes.
4) The link between the two dimensions of educational effectiveness (quality and equity) at the school level by conducting the appropriate analyses with the data of PISA, as they emerged from the relevant research in Cyprus.

In this context, the terms *quality* and *equity* are discussed in the next (second) section of this report. In the third section of this report, the impact of factors associated with economic prosperity on student learning outcomes is discussed through a brief literature review of respective studies in the field of educational effectiveness. In the fourth and fifth sections of this report, the methods that were used to conduct the study and the results of the analyses are presented. Implications of findings for policy and practice are finally drawn, by highlighting the need for the development of policies and the undertaking of initiatives for the promotion of equity especially in the Cyprus educational system.

2. Quality and Equity: The Two Dimensions of Educational Effectiveness

2.1 The two measurement dimensions of educational effectiveness

Historically, the objectives of education are primarily the improvement of *student learning outcomes* in different domains of learning and subject areas, based on a series of criteria set by educational systems (Creemers and Kyriakides 2008). In this context, EER can offer insight into which factors can contribute to enhancing student results. The term "learning outcomes" is used in a broader sense and both quality and equity are treated as criteria for measuring effectiveness in educational systems and schools.

In the case of the *quality dimension*, student achievement gains in the cognitive, affective, psychomotor and meta-cognitive domains are examined. It is generally expected in society that education should achieve high results in all domains of learning. This means that the criteria for

effectiveness will be at the level to be obtained by individual students, classes, and schools with respect to these objectives (*excellence*). Studies conducted in the field of EER have shown that schools which are effective in promoting cognitive outcomes tend to also be effective for affective outcomes by helping students to develop positive attitudes towards schooling (Knuver and Brandsma 1993; Kyriakides 2005). In regard to the way that the quality dimension is measured, an approach that acknowledges the complex and multilevel structure of education is taken into account (Heck and Thomas 2020). Thus, multilevel modelling techniques have been used during the past decades to investigate the impact of effectiveness factors on student learning outcomes (Creemers et al. 2010; Goldstein 2003; Raudenbush and Bryk 1986).

As regards the *equity dimension*, it is important to note that numerous definitions have been provided through early studies in the field of EER (Boaler 2008; Demeuse et al. 2001; Farrel 1999; Gutierrez 2002; Levin 2003; Lewis and Lewis 2008; Post 2004). PISA defines the equity dimension "[…] as providing all students, regardless of gender, family background or socioeconomic status, with opportunities to benefit from education. Defined in this way, equity does not imply that everyone should have the same results. It does mean, however, that students' socioeconomic status or the fact that they have an immigrant background has little or no impact on their performance, and that all students, regardless of their background, are offered access to quality educational resources and opportunities to learn" (OECD 2013, p. 13). Nevertheless, different ways of conceptualizing and measuring equity exist within the research paradigm, based on different philosophical assumptions about the role that the school and/or the educational system must fulfil regarding the reduction of differences in student learning outcomes (Atkinson 2015; Espinoza 2007).

The prevailing approaches to equity are based on either the *meritocratic* (Shepelak and Alwin 1986; Slomczynski and Wesolowski 2001) or the *egalitarian* perspective (Kyriakides et al. 2018; Van Damme and Bellens 2017). The *meritocratic* view of equity is based on the assumption that a positive relation exists between one's merits, talents, and effort to succeed and their desired outcomes: either financial, academic, prestige in society or any other (Gulson and Webb 2012; Kunovich and Slomczynski 2007; McCoy and Major 2007). Supporters of this view assume that the differences identified between students in terms of their learning outcomes can be explained by examining their cognitive abilities, talents and the effort made to succeed. This assumption is partly supported by findings of EER, which reveal the importance of treating aptitude, prior achievement and perseverance as factors that can explain variation in student learning outcomes (Scheerens 2013). However, EER has also shown that students demonstrating the same talents, skills and effort to succeed do not always manage to develop in similar ways and reach the same goals to the same degree (Kyriakides et al. 2019; Sammons et al. 2018). Research findings show that student background factors that are unlikely to change – such as SES, ethnicity and gender – can also explain variation in student learning outcomes (Kyriakides et al. 2019; Scheerens 2016). Even in cases where students are provided with the same learning opportunities at school, the learning opportunities they receive at home may differ to a large extent due to a variety of reasons, such as parents' education, financial and work status (Lim 2013; Moss et al. 2008) and may ultimately lead to variations in student learning outcomes (Scheerens 2014).

Based on the above critiques of the meritocratic view of equity, the *egalitarian* perspective has evolved as the mainstream view of equity. The egalitarian vision of equity takes into consideration the processes outside the school that may affect the actual learning opportunities given to students and, therefore, their academic outcomes. This concept suggests that to better address issues of equity, attempts should be made in order that differences in student background

factors are not reflected in their learning outcomes (Van Damme and Bellens 2017). This perspective also implies that the main responsibility to achieve equity should be placed on society. National/state agencies and schools/teachers are expected to provide further support to those socially disadvantaged groups of students (based on their background characteristics such as SES) to ensure that differences in their learning outcomes are substantially reduced (Kelly 2012; Kyriakides et al. 2018; OECD 2012).

In particular, the extent to which educational systems can both promote their students' learning outcomes (quality) and reduce the impact of SES on student learning outcomes (equity) is investigated in this study. Regarding the evaluation of an educational system as to whether it can promote equity, we support the idea that it is important to consider the impact of student background factors (such as SES) that are unlikely to change on student learning outcomes. At this point, it should be acknowledged that equity in education could also be examined in two ways that are closely linked and can help us analyse the implications of school failure for teachers/schools/systems: *equity as fairness* and *equity as inclusion*. Specifically, school failure can be seen to be twofold in nature. On the one hand, it could be viewed as the failure of an educational system which is unable to provide an education of quality for all. In this case, *inclusion* means ensuring that all students participate in education in an adequate and effective way (Ballarino et al. 2014) and consequently a basic minimum standard education is ensured for each and every student. The *inclusion* perspective has implications for designing effective national reform policies that minimize dropout rates and provide learning opportunities for all children. Secondly, school failure can be attributed to factors beyond those that students can control and are associated with student learning outcomes. In this case, *fairness,* as the second way of examining equity in education, suggests that personal and social circumstances (such as gender, SES or ethnic origin) should not be an obstacle to educational success (Ballarino et al. 2014; Field et al. 2007). In this study, the fairness perspective of equity is examined.

Summing up, each individual school in every country faces a challenge in identifying ways for promoting not only quality but also equity. In an effective educational system, access to resources and opportunities to learn should ensure the successful learning of all learners, implying that school failure will not be determined by factors that students cannot control such as their own socioeconomic background. The importance of using both equity and quality as dimensions for measuring school effectiveness is discussed in the next part of this report by investigating their relationship.

2.2 Research findings on the relationship between quality and equity in education

By introducing two different dimensions of measuring effectiveness, a question that arises is the extent to which teachers/schools/systems can be effective in terms of not only promoting the learning outcomes of their students (quality) but also reducing the impact of student background factors (and especially SES) on student achievement (equity). A group of researchers in psychology, sociology, and economics of education have treated these two dimensions of effectiveness as competing against each other and supported different approaches on how to deal with the "cost" of promoting the one rather the other (Whitty 2001). This can partly be attributed to the fact that there is not enough evidence investigating the relation between the two dimensions of effectiveness in classrooms, schools, and educational systems (Kelly 2012; Kyriakides et al. 2018). In addition, EER reveals that in some countries, teachers and schools matter most for underprivileged and/or initially low-achieving students (Kyriakides 2007;

Scheerens and Bosker 1997; Vanlaar et al. 2016). For example, the results of a longitudinal study conducted by Kyriakides and Creemers (2011) showed that schools which became effective in terms of the equity dimension, managed also to improve their effectiveness status in terms of the quality dimension. This implies that, promoting one of the two dimensions does not mean that this could negatively affect the other one. This finding is in line with the results of the PISA study that "consistently finds that high performance and greater equity in education opportunities and outcomes are not mutually exclusive: one does not have to be sacrificed to achieve the other" (OECD 2013, p. 27).

Finally, stronger relations between the dimensions of quality and equity at the school rather than at the country level have been identified (Micklewright and Schnepf 2007). Beyond the establishment of effective policies in promoting equal educational opportunities to students in socially disadvantaged areas, factors associated with the wider educational environment (Willms 2003) may also contribute to explaining the variation of the achievement-gap based on SES at country level.

The results of the above-mentioned studies showed that there is a need to conduct studies investigating the relationship between quality and equity within and across countries to increase stakeholders' awareness about the importance of reducing the SES gap in student achievement. This is especially important in those countries and schools where final student learning results can be considered satisfactory, but SES still plays a very important role for achieving these results. Hence, the results of the present study on the relation between the two dimensions of effectiveness may help policy makers evaluate policies on promoting quality and equity since they could investigate not only the extent to which students' mean performance has improved but also whether the SES gap in student achievement has been reduced. Since equity in this study is measured by investigating the impact that SES has on student achievement, the next part of this report presents the results of national and international studies investigating the impact of SES on student achievement.

3. The Impact of Factors Associated with Economic Prosperity on Student Achievement

One of the most important and common findings in all available international studies is that student achievement differs significantly across the participating countries. Therefore, there is a question from researchers, policy makers and practitioners as to why some educational systems perform better than others. Since within EER, theoretical models describing educational effectiveness are multilevel in nature (e.g., Creemers 1994; Creemers and Kyriakides 2008; Scheerens 2016), there are factors associated with student learning outcomes operating at student-, classroom-, school-, and system (country)- level. While there are quantitative systematic reviews of the literature regarding classroom factors (e.g., Bardach and Klassen 2020; Bourdeaud'hui et al. 2018; Kyriakides et al. 2013; Scheerens 2016) and school (e.g., Kyriakides et al. 2010; Scheerens 2016), this has not yet been applied to factors at the system level (Scheerens and Blömeke 2016; Scheerens et al. 2015). In this report, we focus only on factors found in the literature that are associated with economic prosperity.

Research in the field of educational effectiveness conducted over five decades ago revealed that a strong relationship exists between SES and all kinds of academic achievement variables (Coleman et al. 1966). Consequently, measures of SES have been used by researchers in the field of education in different ways, either in designing interventions (e.g. used as covariance to control

for bias, especially in quasi-experimental studies) or in searching for differential effects of interventions (e.g. examining whether method A is more effective with low-SES students, whereas method B is more effective with high-SES students) or in trying to establish the validity of causal models (e.g. SES is used as one of the causal agents to predict student learning outcomes). However, by looking at the literature on the role of SES, one cannot easily find a commonly accepted definition of this important effectiveness factor. White (1982) argues that "even though 'everybody knows' what is meant by SES, a wide variety of variables is used as indicators of SES" (p. 462). It is also claimed that widely accepted definitions of SES are difficult to find. More than 90 years ago, Chapin (1928) defined SES as the "position that an individual or family occupies with reference to the prevailing average of standards of cultural possessions, effective income, material possessions, and participation in group activity in the community" (p. 99). A more formal definition of SES refers to the relative position of a family or individual on a hierarchical social structure, based on their access to, or control over, wealth, prestige, and power (Mueller and Parcel 1981). It is usually operationalized as a composite measure of income, level of education, and occupational prestige (Dutton and Levine 1989; Mueller and Parcel 1981). The community can be any unit in which individuals are clustered, including geographically defined units such as a country, province or state, city or neighbourhood. The community can also be a social or organizational unit such as a school or workplace. The definition states "individuals" in a community, to emphasize the importance of using individual data to measure the impact of SES on student achievement.

By looking at how SES is measured, one can also see that researchers often considered SES to be a function of three major factors: 1) family income; 2) parents' educational level; and 3) parents' occupation. Even though different SES measures have been used over the years e.g., *Index of Status Characteristics* (Warner et al. 1949), and *Two-Factor Index of Social Position* (Hollingshead and Redlich 1958), most cross-national studies agree that family background characteristics have an impact on their child's learning outcomes. Explicitly, children from high-SES families have better schooling outcomes (Baker et al. 2002; Buchmann and Hannum 2001; Chiu and Khoo 2005; Hanushek and Luque 2003). However, quantitative syntheses of studies investigating the effect of SES on student achievement (e.g., Sirin 2005; White 1982) reveal that several studies report either low or moderate correlations of SES with achievement.

Specifically, in the first quantitative synthesis of almost 200 studies, White (1982) focused on the relation between SES and academic achievement. It was found that as typically defined (i.e., taking into account parents' income, education, and/or occupation status) and typically used (i.e., treated as a student level variable), SES is only weakly correlated with academic achievement. However, when researchers use aggregated measures of SES, they usually report extremely high correlations between SES and academic achievement. This meta-analysis also revealed that different indicators are used to measure SES. This has created an ambiguity in interpreting research findings on the impact of SES on student achievement. Traditional indicators of occupation, education, and income were found to be frequently considered in defining SES. Nevertheless, frequent references to factors such as size of family, educational aspirations, ethnicity, mobility, and presence of reading materials in the home were also made.

A second meta-analysis (Sirin 2005), which was based on American studies conducted from 1990 until 2000, revealed similar findings about the effect of SES on student achievement implying that the SES-gap in educational achievement is not as big as it was assumed in the early 1970s. Regarding the measurement of SES, it was also found that researchers in the 1990s treated SES as a multi-dimensional construct and for this reason different indicators were used to measure it.

However, there seems to be an agreement on the Duncan et al. (1972) definition of the tripartite nature of SES that incorporates parental income, parental education, and parental occupation as the three main indicators of SES (Gottfried 1985; Hauser 1994; Mueller and Parcel 1981). Many empirical studies examining the relations among these components reported moderate correlations and found that the components of SES are unique since each one of them measures a substantially different aspect of SES that should be considered to be separate from the others (Bollen et al. 2001; Hauser and Huang 1997). Specifically, parental income as an indicator of SES reflects the potential for social and economic resources that are available to the student. The second traditional SES component, parental education, is an indicator of parents' income because income and education in most countries are correlated. The third SES component, occupation, is ranked on the basis of the education and income resulting from a particular occupation (Hauser 1994). This meta-analysis also revealed that the type of SES measure changed the relationship between SES and academic achievement. Specifically, the average correlations between SES and academic achievement were found to range from 0.25 (when SES was operationalized by using neighbourhood characteristics as an indicator of family SES) to 0.47 (when SES was operationalized by using home resources as an indicator of family SES). More commonly used SES components such as education, occupation, income, and eligibility for school lunch programs produced rather similar results. Finally, this meta-analysis revealed that the effect of SES was not equally strong for different groups of students. Sirin (2005) pointed out that one of the main findings of his review was that for minorities, SES did not seem to be as strongly related to academic achievement as it was for their white peers.

Moreover, researchers have studied how the achievement gap between students coming from different socioeconomic backgrounds (namely the SES gap) changes over time for specific social policies and how it is mediated and moderated by risk and protective factors (e.g., Heath and Clifford 1990; Kyriakides 2005; Willms and Raudenbush 1989). These studies have implications for researchers on promoting equity in education since they reveal the importance of investigating the extent to which the SES gap can be altered by specific factors at the school and system levels (Willms 2006). To search for variations in the effect of SES in different schools and countries, secondary analyses of international studies have been conducted (e.g., Caro and Lenkeit 2012; Kyriakides et al. 2018; Willms 2003). This is partly because the assumption that not only school factors but also system factors may explain variation on the effect of SES could not be tested by studies conducted in a single country. For example, PISA 2012 shows that across OECD countries, a more socioeconomically advantaged student scores 39 points higher in Mathematics – the equivalent of nearly one year of schooling – than a less-advantaged student. Additionally, international studies show that the impact of SES on student outcomes varies not only across, but also within, countries (Caro and Lenkeit 2012; Kyriakides et al. 2018). More specifically, cross-country analysis of PISA has revealed that almost 15% of variance in student achievement can be explained by the PISA index of economic, social and cultural status (see OECD 2012). However, in some countries, such as the Slovak Republic, Chile, Hungary and Peru, this index can explain more than 22% of variance in student achievement, whereas in other countries, such as Macao-China and Qatar, this index can explain no more than 6% of variance. It is finally important to stress that secondary analyses of international studies also reveal an equally important variation in the impact of SES on student learning outcomes at the school level (Kyriakides et al. 2018).

At the system level, there are factors concerned with the prosperity of a country that are found to be associated with student learning outcomes, such as the Gross Domestic Product (GDP)[1] and Gross National Income (GNI)[2]. GDP is the monetary value of all finished goods and services made within a country during a specific period and this indicator can provide an economic snapshot of a country, used to estimate the size of an economy and growth rate. GNI measures the total domestic and foreign value added claimed by residents and comprises GDP plus net receipts of primary income (compensation of employees and property income) from non-resident sources. A recent meta-analysis of studies investigating the impact of system level factors on student learning outcomes has found the importance of considering alternative measures of the general affluence of a country (e.g., child poverty, proportion of economically disadvantaged students) (Mejía-Rodríguez 2022). The same meta-analysis has also found that when significant effects are reported, they usually showed a positive association and as a whole, the average effect size of general affluence being 0.27.

The World Bank (n.d.) also reports that the most frequently used variable to measure inequality at the system level was the Gini index, which measures the extent to which the distribution of income deviates from a perfectly equal distribution. Some studies also include the level of development in a country to control for differences across contexts in which education systems operate. An example is the Human Development Index (HDI). The HDI includes information on countries' life expectancy, expected and mean years of schooling, and GNI per capita (United Nations Development Programme 2020). The relationship between HDI and student achievement was found to be statistically significant and positive in 63% of the effect sizes reported in a recent meta-analysis (Mejía-Rodríguez 2022). Another frequently used indicator was the level of adult literacy in a system or country, measured by the proportion of people aged 16-64 that has finished at least secondary education. Examples of individual indicators of the level of development in a country are life expectancy, fertility rate, child mortality, and crime rate. For the purposes of the present study, the variables SES, GDP and GNI are used to search for the extent to which these factors explain variation in different types of student learning outcomes.

4. Methods

This section presents the methods of this study conducted to investigate the relationship between the dimension of quality and the dimension of equity at the level of the educational system through data from the last two cycles of PISA (i.e., years 2015 and 2018). PISA is an international survey which aims to evaluate education systems worldwide by testing the skills and knowledge of 15-year-old students. Initiated in 2000, PISA studies are conducted every three years, and mainly focus on three subject matters: Mathematics, Reading, and Science. PISA studies measure skills and knowledge of students of 15 years of age, near the end of their compulsory education (OECD 2017a); therefore, these studies target the student population based on age, instead of grade-level. PISA studies are also literacy- rather than curriculum- oriented. This suggests that instead of examining mastery of specific school curricula, PISA studies investigate the extent to which students are able to apply knowledge and skills in the subject areas under consideration in a range of "authentic" situations, including analysing, reasoning, communicating, interpreting, and solving problems (Lingard and Grek 2008). Due to time restrictions, each cycle is focused on

[1] See https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD
[2] See https://data.worldbank.org/indicator/NY.GNP.PCAP.CN

a specific subject, but for the purposes of this study, we used data on student achievement in all three subject areas mentioned above. So far, more than 90 countries have participated in PISA studies, which mainly use student tests and self-reports (of students, teachers, school headmasters, and parents) as the main data collection instruments. Students and their school principals also answer questionnaires to provide information about students' background, school and learning experiences and about the school learning environment.

4.1 Participants

For each PISA cycle, a two-stage sampling approach was used. The first-stage sampling units consisted of individual schools having 15-year-old students. Schools were sampled systematically from a comprehensive national list of all PISA-eligible schools with probabilities that were proportional to a measure of size. The measure of size was a function of the estimated number of PISA-eligible 15-year-old students enrolled in the school. This is referred to as systematic Probability Proportional to Size (PPS) sampling. Prior to sampling, schools in the sampling frame were assigned to mutually exclusive groups based on school characteristics called explicit strata, formed in particular to improve the precision of sample-based estimates. The second-stage sampling units were students within sampled schools. Once schools were selected to be in the sample, a complete list of each sampled school's 15-year-old students was prepared. More information on the sampling procedures of each PISA cycle can be found in the technical report of each cycle (see OECD 2017b; OECD 2020).

For the purposes of this study and more specifically to answer research questions 1, 2 and 3, separate across-countries multilevel analyses for each PISA cycle were conducted by using MLwiN (Rasbash et al. 2005) and the data were conceptualized as a three-level model, consisting of student at the first level, school at the second level, and country at the third level (see also Data Analysis for more details). Consequently, the data from PISA 2015 consisted of 69 countries, 7288 schools and 465624 students, whereas the data from PISA 2018 comprised of 77 countries, 9721 schools and 582796 students. To answer the last research question that is concerned with the relation between quality and equity at the school level, data from the participation of Cyprus in PISA 2015 and 2018 were used, and more specifically the sample involved 124 schools and 5468 students from PISA 2015 and 89 schools and 5407 students from PISA 2018.

4.2 Variables

The dependent variable was Student Achievement. Item Response Theory (IRT) models were used to create scores standardized at an international mean of 500 and standard deviation of 100. Students' scores are in the form of ten plausible values rather than a single score. These measures were constructed by the PISA consortium and are included in the datasets publicly available. Details on the construction of the achievement measures can be found in the technical report of each PISA cycle (see OECD 2017b; OECD 2020).

Explanatory variables included student socioeconomic background measures (SES, GDP, GNI). PISA attempts to measure SES by collecting data from students on three family background variables: the highest level of parental education among the two parents (in number of years of education according to the ISCED classification, *HISCED*), the highest parental occupation among the two parents (HISEI) and the number of home possessions. A global SES indicator was also used (ESCS) conceptualized as "a comprehensive measure of student socioeconomic

background" (OECD 2009, p. 41). The rationale for using these three components was that socio-economic status has usually been seen as based on education, occupational status and income (see third part of this report). As no direct income measure has been available from the PISA data, the existence of household items has been used as a proxy for family wealth. In this study, the global SES indicator (ESCS) is, therefore, used to measure the impact of SES on student achievement.

As regards system level economic measures, there are many factors concerned with the prosperity of a country that are found to be related with student learning outcomes, and those are mentioned in the third section of this report. For the purposes of this study, the Gross Domestic Product (GDP) and Gross National Income (GNI) indicators are used (more details about these indicators can be found in the third section of this report). These indicators were derived from the World Development Indicators database of the International Comparison Program of the World Bank[3,4].

4.3 Analysis

Different analyses have been conducted to provide answers to each of the four research questions of this study. The type of analyses used to address each question is discussed below.

Research Question 1: The extent to which variables associated with economic prosperity (SES, GDP and GNI) can explain differences in student learning outcomes and also explain why some countries have better learning outcomes than others.

Multilevel regression analyses across countries participating in PISA 2015 and PISA 2018 were conducted, separately for each PISA cycle (i.e., 2015 and 2018) and for each subject (i.e., Mathematics, Science and Reading) by using MLwiN (Rasbash et al. 2005). Multilevel modelling techniques allow the researcher to investigate the extent to which clustering effects are present in the data, for example, whether the variation in achievement can be divided into individual-level and group-level components. Additionally, multilevel modelling provides a framework in which a researcher can add explanatory variables at their correct level of the data order by avoiding aggregating or disaggregating the data to a single level of analysis (Heck and Thomas 2020). Therefore, the data of these analyses were conceptualised as a three-level model, consisting of students at the first level, schools at the second level, and countries at the third level. Consequently, these six analyses helped us find out whether the variables associated with economic prosperity can be treated as system level factors irrespective of the type of learning outcome taken into account (i.e., Mathematics, Science and Reading) and the cycle of PISA (2015 or 2018).

Research Question 2: Whether educational systems which appear effective in relation to quality are also effective in relation to the equity dimension of effectiveness.

To measure the effectiveness status of the educational systems in terms of the quality dimension, the following approach was used. Based on the results of the random slop model (of each of the six analyses) that allows the effect of the SES indicator to vary at school and system level (i.e., Model 3), the difference between the expected and the actual score for each country was plotted by considering its residual of the intercept value (V_{0k}). The standard error of estimate for each

[3] See https://data.worldbank.org/indicator/NY.GDP.PCAP.PP.CD
[4] See https://data.worldbank.org/indicator/NY.GNP.PCAP.CN

country was also taken into account and is represented by the length of a vertical line. This line can be conceptualized as the range within which we are 95% confident that the true estimate of the country's residual lies (Goldstein 2003). Thus, where this vertical line does not cross the horizontal zero line and is also situated below the zero line, the country it represents is considered as one of the *least effective* countries of our sample in terms of the quality dimension. Moreover, where this line does not cross the horizontal zero line and is situated above the zero line, the country it represents is characterized as one of the *most effective* countries. All the other countries are characterized as *typical*. To estimate the effectiveness status of countries in terms of the equity dimension, the residual value of each country that is concerned with the impact of SES on achievement (i.e., V_{1k}) was taken into account as well as its standard error. Following the same approach to the one presented above, we were able to classify countries into three groups: *most effective, typical,* and *least effective* in terms of the equity dimension. Since SES is expected to have a very small effect on achievement, we treated as most effective those countries with vertical lines that do not cross the horizontal zero line and are also situated below the zero line. By using this approach, we were able to classify each participating county into one of the three categories (*most effective, typical* and *least effective*) in terms of each dimension (i.e., quality and equity) and search for the extent to which countries considered effective in terms of the quality dimension tend to be considered effective in terms of the equity dimensions.

Research Question 3: Whether changes in the effectiveness of countries in relation to the dimension of equity can lead to the improvement of student learning outcomes.

Based on the results of the analyses used to answer research question 2, it was possible to compare the effectiveness status of each country in PISA 2015 in each dimension (quality and equity) with its relevant effectiveness status in PISA 2018. In this way, the participating countries were classified into three categories by considering whether they *remained equally effective* from 2015 to 2018 or managed to *improve their effectiveness status* or to *decline*. This classification is done for each subject separately and for each dimension (quality and equity) separately. In addition, at the next step of the analysis, for each subject, we classified the countries by considering the type of change in their effectiveness status on each of the two dimensions of measuring effectiveness (quality and equity). This helped us answer the question about the relationship of equity with quality by considering the type of changes that are observed from 2015 to 2018 in each dimension at the country level.

Research Question 4: The link between the two dimensions of educational effectiveness (quality and equity) at the school level on the basis of PISA data, as they emerged from the relevant research in Cyprus.

This research question refers to the relation between the two dimensions of effectiveness (quality and equity) at the level of the school. To achieve this aim, we made use of the data of a single country (i.e., Cyprus). Consequently, to answer this question, we first analyzed the data of Cyprus from the two cycles of PISA (2015 and 2018) using separate multilevel modelling techniques (students within schools) in each subject (see the method used to answer research question 1). Then, we used the same approach as for research question 2, to classify participating schools into three categories: *most effective, typical* and *least effective* – in terms of each dimension (quality and equity). This was done separately for each PISA cycle and for each subject. To identify the effectiveness status of schools in terms of each dimension, we made use of the value of the two relevant school level residuals (i.e., U_{0k} in the case of quality and U_{1k} in the case of equity). It is noted that we cannot match the schools of the two consecutive cycles of PISA. It is, therefore, not possible to investigate the relationship between changes that may occur in the

effectiveness status of schools in terms of each dimension from 2015 to 2018. Since all analyses were conducted separately for each subject, we also investigated the extent to which answers to the above questions that emerged from these three subjects were similar.

5. Results

Tables 1 up to 3 present the results of the across countries multilevel regression analyses concerned with achievement in each subject separately per PISA cycle. A comparison of the findings which emerged from each empty model reveals that the six separate analyses generated similar answers about the system and school effects in each subject. Both school and country statistically significant effects on achievement in each subject were detected. In model 1, the two student background factors (i.e., SES and gender) were added to the empty model. All six analyses revealed that both factors have a statistically significant effect on student achievement and a significant percentage of variance was explained. In the case of gender, boys were found to outperform girls in mathematics whereas in reading girls had better results than boys. In model 2, the two factors concerned with the prosperity of a country (i.e., GDP and GNI) were added to model 1. Only GDP was found to have a significant effect on student achievement in each subject. The fact that GNI was not found to be associated with student achievement can be attributed to multicollinearity. By removing the GDP from model 2, significant effects of GNI on student achievement were detected. However, the model that had a better fit to the data was the one that took into account the effect of GDP. For this reason, in each analysis, the GDP variable was kept in model 2 (see Tables 1-3). In the final model, a random slope model was run since the effect of SES on student achievement was allowed to vary at both the school and the system level (see model 3). For each PISA cycle, the analyses for each subject revealed that all parameter estimates of the variances at the random part of Model 3 were statistically significant at .05 level. Moreover, the likelihood statistic shows a statistically significant change between Model 2 and Model 3 ($p < 0.001$) meaning that there is a differential effect of SES at both the country and school level in each subject. By considering the random part at the country level, the correlation between the residual of the intercept (V_0) and the residual of the slope for SES (V_1) for each subject was estimated. In each PISA cycle, a negative statistically significant relation at .05 level in each subject was identified. This implies that the achievement gap (in each subject) based on SES tends to be smaller in countries which achieve better learning outcomes after controlling for contextual factors. By taking into account the random part of the model at the school level, it was also possible to estimate the correlation between the relevant residuals at the school level (i.e., U_0 and U_1). Both PISA studies reveal that for each subject, these correlation coefficients were statistically significant at .001 level. These findings show that the achievement gaps based on SES tend to be smaller in schools found to be more effective in terms of the quality dimension (i.e., the overall student achievement, after controlling for the effect of contextual factors).

TABLE 1

Parameter estimates (and standard errors) for the analysis of Mathematics achievement of PISA 2015 and 2018

	Year 2015				Year 2018			
	Model 0	**Model 1**	**Model 2**	**Model 3**	**Model 0**	**Model 1**	**Model 2**	**Model 3**
Fixed Part								
Intercept	459.81(6.25)**	458.35(5.78)**	457.05(5.29)**	453.76(5.47)**	457.03(6.00)**	456.42(5.18)**	455.17(4.61)**	451.48(4.81)**
Student Level								
Gender (0=girl, 1=boy)		6.88(0.23)**	6.51(0.24)**	6.94(0.24)**		4.87(0.21)**	4.86(0.21)**	5.30(0.21)**
SES		25.65(0.12)**	25.67(0.13)**	26.21(0.98)**		25.68(0.11)**	25.78(0.11)**	25.77(0.95)**
System level								
GDP			0.001(0.0001)**	0.001(0.0001)**			0.001(0.0001)**	0.001(0.0001)**
Random Part								
Level 1 (student) random effects								
Intercept: $Var(R_{ijk}) = \sigma^2_{eo}$	6694.00(13.16)**	6188.56(12.36)**	6193.39(12.93)**	6055.17(12.71)**	6865.67(12.51)**	6344.76(11.70)**	6345.70(11.85)**	6191.83(11.62)**
Level 2 (school) random effects								
Intercept: $Var(U_{0k}) = \sigma^2_{u0}$	1867.26(33.15)**	1222.22(22.94)**	1197.49(23.19)**	1256.27(24.69)**	1867.64(30.25)**	1190.78(20.36)**	1165.65(20.30)**	1233.45(21.69)**
SES: $Var(U_{1k}) = \sigma^2_{u1}$				138.03(7.47)**				152.35(6.75)**
$Cov(U_{0k},U_{1k}) = \sigma_{v01}$				-104.57(4.12)**				-110.62(3.74)**
Level 3 (system) random effects								
Intercept: $Var(V_{0k}) = \sigma^2_{v0}$	2807.32(473.82)**	2380.34(403.07)**	1892.97(23.19)**	2020.50(349.38)**	2846.66(455.81)**	2124.79(339.29)**	1616.31(264.18)**	1757.07(287.12)**
SES: $Var(V_{1k}) = \sigma^2_{v1}$				165.70(48.98)*				114.67(42.26)*
$Cov(V_{0k},V_{1k}) = \sigma_{v01}$				-62.35(11.38)**				-66.02(11.19)**
Significance Test								
Loglikelihood								
X^2	6134117.232	5904113.984	5403449.499	5397106.763	7169540.517	6950001.596	6776899.883	6768035.474
Reduction		230003.3	500664.5	6342.7		219539	173101.7	8864.4
Degrees of freedom		2	1	4		2	1	4
p value		.001	.001	.001		.001	.001	.001

Note: SES = socioeconomic status; *statistically significant effect at .05 level; **statistically significant effect at .01 level

TABLE 2

Parameter estimates (and standard errors) for the analysis of Science achievement of PISA 2015 and 2018

	Year 2015				Year 2018			
	Model 0	**Model 1**	**Model 2**	**Model 3**	**Model 0**	**Model 1**	**Model 2**	**Model 3**
Fixed Part								
Intercept	465.03(5.69)**	466.12(5.29)**	464.54(4.98)**	460.69(5.09)**	455.69(5.53)**	458.95(4.80)**	458.23(4.44)**	454.37(4.61)**
Student Level								
Gender (0=girl, 1=boy)		1.72(0.23)**	1.25(0.24)**	1.73(0.24)**		-2.76(0.21)**	-2.83(0.22)**	-2.84(0.21)**
SES		26.06(0.13)**	26.13(0.13)**	26.86(1.11)**		25.14(0.11)**	25.25(0.11)**	25.35(0.94)**
System level								
GDP			0.001(0.000)**	0.001(0.000)**			0.001(0.000)*	0.001(0.000)*
Random Part								
Level 1 (student) random effects								
Intercept: $Var(R_{ijk}) = \sigma^2_{eo}$	7060.52(13.89)**	6559.15(13.10)**	6543.75(13.67)**	6390.55(13.42)**	6902.22(12.58)**	6406.42(11.81)**	6418.09(11.98)**	6272.81(11.77)**
Level 2 (school) random effects								
Intercept: $Var(U_{0k}) = \sigma^2_{u0}$	1925.29(34.27)**	1249.13(23.54)**	1236.71(23.99)**	1298.84(25.48)**	1929.19(31.09)**	1230.94(20.86)**	1210.10(20.95)**	1272.83(22.31)**
SES: $Var(U_{1k}) = \sigma^2_{u1}$				148.82(7.70)**				163.86(6.81)**
$Cov(U_{0k},U_{1k}) = \sigma_{v01}$				-105.68(4.21)**				-105.96(3.65)**
Level 3 (system) random effects								
Intercept: $Var(V_{0k}) = \sigma^2_{v0}$	2307.47(391.43)**	1978.82(336.36)**	1668.63(290.21)**	1749.08(304.27)**	2405.82(386.25)**	1820.22(291.57)**	1492.24(244.30)**	1607.19(263.07)**
SES: $Var(V_{1k}) = \sigma^2_{v1}$				171.35(51.28)*				117.13(40.32)*
$Cov(V_{0k},V_{1k}) = \sigma_{v01}$				-79.91(14.35)**				-64.51(10.93)**
Significance Test								
Loglikelihood								
X^2	6161946.000	5933467.437	5428930.732	5421951.148	7173009.706	6955959.195	6783707.635	6775467.740
Reduction		228478.6	504536.7	6979.6		217050.6	172251.5	8239.9
Degrees of freedom		2	1	4		2	1	4
p value		.001	.0001	.001		.001	.0001	.001

Note: SES = socioeconomic status; *statistically significant effect at .05 level; **statistically significant effect at .01 level

TABLE 3

Parameter estimates (and standard errors) for the analysis of Reading achievement of PISA 2015 and 2018

	Year 2015				Year 2018			
	Model 0	**Model 1**	**Model 2**	**Model 3**	**Model 0**	**Model 1**	**Model 2**	**Model 3**
Fixed Part								
Intercept	460.21(5.88)**	475.78(5.38)**	474.72(5.11)**	471.62(5.22)**	451.29(5.64)**	467.59(4.85)**	466.87(4.44)**	463.38(4.57)**
Student Level								
Gender (0=girl, 1=boy)		-26.31(0.24)**	-27.09(0.25)**	-26.61(0.25)**		-27.96(0.22)**	-28.09(0.23)**	-27.62(0.23)**
SES		26.32(0.13)**	26.64(0.14)**	27.17(1.05)**		26.20(0.12)**	26.31(0.12)**	26.16(0.93)**
System level								
GDP			0.001(0.000)*	0.001(0.000)*			0.001(0.000)*	0.001(0.000)*
Random Part								
Level 1 (student) random effects								
Intercept: $Var(R_{ijk}) = \sigma^2_{eo}$	7633.86(15.01)**	6955.55(13.89)**	6985.87(14.59)**	6829.56(14.34)**	7821.75(14.25)**	7076.56(13.05)**	7079.08(13.22)**	6917.44(12.99)**
Level 2 (school) random effects								
Intercept: $Var(U_{0k}) = \sigma^2_{u0}$	2204.09(39.06)**	1416.04(26.47)**	1427.41(27.56)**	1542.52(29.88)**	2129.14(34.41)**	1295.39(22.07)**	1276.25(22.20)**	1360.05(23.91)**
SES: $Var(U_{1k}) = \sigma^2_{u1}$				115.45(8.49)**				163.64(7.48)**
$Cov(U_{0k},U_{1k}) = \sigma_{v01}$				-108.15(4.44)**				-123.95(4.18)**
Level 3 (system) random effects								
Intercept: $Var(V_{0k}) = \sigma^2_{v0}$	2460.00(417.99)**	2049.36(348.93)**	1757.55(306.19)**	1834.40(319.85)**	2506.76(402.83)**	1854.94(297.25)**	1495.12(244.98)**	1581.31(259.15)**
SES: $Var(V_{1k}) = \sigma^2_{v1}$				129.49(48.03)*				94.69(39.03)*
$Cov(V_{0k},V_{1k}) = \sigma_{v01}$				-70.87(12.83)**				-63.34(10.80)**
Significance Test								
Loglikelihood								
X^2	6203276.965	5963719.780	5459817.957	5453563.202	7249320.467	7015008.197	6840466.684	6832527.606
Reduction		239557.2	503901.8	6254.7		234312.3	174541.5	7939
Degrees of freedom		2	1	4		2	1	4
p value		.001	.0001	.001		.001	.0001	.001

Note: SES = socioeconomic status; *statistically significant effect at .05 level; **statistically significant effect at .01 level

To further examine the relation between the two dimensions of educational effectiveness (quality and equity), for each subject separately, we estimated the effectiveness status of each country participating in each study in relation to each dimension of effectiveness. Tables 4 up to 9 present the distribution of countries in terms of their effectiveness status in both the quality and equity dimensions. The following observations arise from these tables. First, there is almost no country which is considered as the most effective in terms of one dimension and as a least effective in terms of the other dimension. There are only two exceptions. Analysis of PISA 2015 data concerned with Science achievement, revealed one country which was among the most effective in terms of quality and among the least effective in terms of equity (see Table 5). A similar finding emerged from PISA 2018 data on reading achievement, since one country was among the most effective in terms of quality and among the least effective in terms of equity (see Table 9). Second, all six analyses revealed that the great majority of the countries that were considered as among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension. For example, Table 6 shows that 14 out of 18 countries found to be among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension. Third, all six analyses revealed that the majority of the countries which were found to be among the least effective in terms of the quality were also among the least effective in terms of the equity dimension. It can finally be argued that most countries were found to belong to the same category in terms of the two dimensions of effectiveness and the figures of Tables 4-9 seem to reveal a close relationship between quality and equity at country level.

TABLE 4

The distribution of countries in terms of their effectiveness status in Mathematics in both quality and equity dimensions (Data from PISA 2015)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	13	3	0	16
Typical	5	27	6	38
Least Effective	0	2	13	15
Total	18	32	19	69

TABLE 5

The distribution of countries in terms of their effectiveness status in Science in both quality and equity dimensions (Data from PISA 2015)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	12	2	0	14
Typical	5	30	6	41
Least Effective	1	2	11	14
Total	18	34	17	69

TABLE 6

The distribution of countries in terms of their effectiveness status in Reading in both quality and equity dimensions (Data from PISA 2015)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	14	5	0	19
Typical	4	27	2	33
Least Effective	0	4	13	17
Total	18	36	15	69

TABLE 7

The distribution of countries in terms of their effectiveness status in Mathematics in both quality and equity dimensions (Data from PISA 2018)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	15	3	0	18
Typical	5	33	4	42
Least Effective	0	2	15	17
Total	20	38	19	77

TABLE 8

The distribution of countries in terms of their effectiveness status in Science in both quality and equity dimensions (Data from PISA 2018)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	15	2	0	17
Typical	4	36	4	44
Least Effective	0	1	15	16
Total	19	39	19	77

TABLE 9

The distribution of countries in terms of their effectiveness status in Reading in both quality and equity dimensions (Data from PISA 2018)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	17	1	0	18
Typical	3	35	4	42
Least Effective	1	2	14	17
Total	21	38	18	77

Subsequently, for each subject, it was possible to compare the effectiveness status of each country in 2015 in each dimension of measuring effectiveness with its relevant effectiveness status in 2018. Table 10 illustrates the distribution of changes in the quality dimension of the effectiveness status of countries participating both in PISA 2015 and PISA 2018 in each subject separately. The relevant distribution of changes in the effectiveness status of countries in terms of the equity dimension is shown in Table 11. The following observations arise from these tables. First, for each subject, no change in the effectiveness status of at least 70% of the country sample in either the quality or the equity dimension can be observed. For example, 50 out of 69 countries managed to remain equally effective in terms of the quality dimension in mathematics (see Table 10). It is also observed that 54 out of 69 countries managed to remain equally effective in terms of the equity dimension in mathematics (see Table 11). Second, in each subject, more than 5 countries managed to improve their effectiveness status in regard to either the equity or the quality dimension. For example, 6 countries managed to improve their effectiveness status in terms of the quality dimension in reading and 9 countries managed to improve their effectiveness status in terms of the equity dimension. In each subject, a decline in the effectiveness status of at least 5 countries was also observed in terms of each dimension. Third, extreme changes in the effectiveness status of the countries in terms of equity are not observed. In regard to quality, only one extreme change was observed since one country managed to improve from least to most effective in Mathematics. Finally, for each subject, we attempted to compare the countries in terms of the type of change in their effectiveness status on each of the two dimensions of measuring effectiveness (see Table 12). It is important to note that there was no country which managed to improve its effectiveness status in terms of one dimension and at the same time decline its effectiveness status in terms of the other dimension. Moreover, the same type of changes in the effectiveness status in terms of the two dimensions are observed in almost 80% of countries. For example, stability in the effectiveness status in terms of both dimensions in science was observed in 47 countries. Improvement was also observed in 3 countries whereas decline in both dimensions was observed in 5 countries. These results seem to reveal that countries not only tend to perform equally well in terms of each effectiveness dimension (see Tables 4-9) but also that in most countries similar types of changes in their effectiveness status in terms of both quality and equity are observed (see Table 12).

TABLE 10

The distribution of countries according to their effectiveness status (quality dimension) in Mathematics, Science and Reading from 2015 to 2018

Groups of countries	Mathematics	Science	Reading
A) Stability			
Remain Typical	23	24	28
Remain Least Effective	14	13	12
Remain Most Effective	13	12	14
B) Improvement			
From Least Effective to Typical	4	4	3
From Least Effective to Most Effective	1	0	0
From Typical to Most Effective	4	4	3
C) Declining			
From Most Effective to Typical	5	6	4
From Typical to Least Effective	5	6	5
From Most Effective to Least Effective	0	0	0

TABLE 11

The distribution of countries according to their effectiveness status (equity dimension) in Mathematics, Science and Reading from 2015 to 2018

Groups of countries	Mathematics	Science	Reading
A) Stability			
Remain Typical	31	36	24
Remain Least Effective	11	12	13
Remain Most Effective	12	11	14
B) Improvement			
From Least Effective to Typical	4	2	4
From Least Effective to Most Effective	0	0	0
From Typical to Most Effective	3	3	4
C) Declining			
From Most Effective to Typical	4	3	5
From Typical to Least Effective	4	2	5
From Most Effective to Least Effective	0	0	0

TABLE 12

Changes in the effectiveness of countries (from 2015 to 2018) in relation to both dimensions of effectiveness (quality and equity) in each subject

Equity \ Quality	Stability	Improvement	Declining	Total
Mathematics				
Stability	48	4	2	54
Improvement	2	5	0	7
Declining	0	0	8	8
Total	50	9	10	69
Science				
Stability	47	5	7	59
Improvement	1	3	0	5
Declining	1	0	5	5
Total	49	8	12	69
Reading				
Stability	49	1	1	51
Improvement	3	5	0	8
Declining	2	0	8	10
Total	54	6	9	69

The last part of this section is concerned with the analyses of PISA data from the two PISA cycles (2015 and 2018) in Cyprus. This is an attempt to explore the relation between the two dimensions of educational effectiveness at the school level (see research question 4). Tables 13 to 15 present the results of the multilevel regression analyses concerned with achievement in each subject separately per PISA cycle in Cyprus. A comparison of the findings which emerged from each empty model reveals that the six separate analyses generated similar answers about the school effects in each subject. The school effect was found to be relatively higher than what was found from various effectiveness studies conducted in Cyprus (e.g., Ioannou et al. 2018; Kyriakides et al. 2019; Kyriakides et al. 2019) but this can be attributed to the fact that these secondary analyses were not in a position to control for the class effect due to the sampling procedure of PISA. In model 1, the two student background factors (i.e., SES and gender) were added to the empty model. All six analyses revealed that both factors have a statistically significant effect on student achievement and a significant percentage of variance was explained. In model 2, a random slope model was run since the effect of SES on student achievement was allowed to vary at the school level. For each PISA cycle, the analyses for each subject reveal that all parameter estimates of the variances at the random part of Model 2 were statistically significant at .05 level. Moreover, the likelihood statistic shows a statistically significant change between Model 1 and Model 2 ($p < 0.001$) meaning that there is a differential effect of SES at the school level in each subject in Cyprus. By taking into account the random part at the school level, the correlation between the residual of the intercept (U_0) and the residual of the slope for SES (U_1) for each subject was estimated. In each PISA cycle, a negative statistically significant relation at .05 level in each subject was identified. This implies that the achievement gap (in each subject) based on SES tends to be smaller in schools which achieve better learning outcomes after controlling for contextual factors.

TABLE 13

Parameter estimates (and standard errors) for the analysis of Mathematics achievement of PISA 2015 and 2018, in Cyprus

	Year 2015			Year 2018		
	Model 0	**Model 1**	**Model 2**	**Model 0**	**Model 1**	**Model 2**
Fixed Part						
Intercept	414.84(5.14)**	423.85(3.67)**	422.85(3.75)**	444.05(5.80)**	446.86(4.31)**	445.83(4.39)**
Student Level						
Gender (0=girl, 1=boy)		5.25(2.21)*	5.52(2.20)*		3.88(2.33)	4.18(2.32)
SES		14.29(1.32)**	14.04(1.64)**		15.42(1.35)**	15.08(1.81)**
School level						
Average SES		54.58(6.09)**	53.08(6.20)**		68.86(9.47)**	67.33(9.47)**
Random Part						
Level 1 (student) random effects						
Intercept: $Var(R_{ijk}) = \sigma^2_{eo}$	6166.94(118.15)**	6057.98(117.11)**	6012.29(116.99)**	7027.27(135.07)**	6836.45(132.53)**	6771.68(132.05)**
Level 2 (school) random effects						
Intercept: $Var(U_{0k}) = \sigma^2_{u0}$	2827.80(408.76)**	1079.51(175.29)**	1112.90(183.87)**	2688.72(440.57)**	1234.26(219.96)**	1277.38(227.24)**
SES: $Var(U_{1k}) = \sigma^2_{u1}$			135.66(57.11)*			135.91(66.62)*
$Cov(U_{0k},U_{1k}) = \sigma_{v01}$			-69.21(32.33)*			-95.07(37.40)*
Significance Test						
Loglikelihood						
X^2	64746.395	63360.584	63352.049	64613.758	63283.374	63267.874
Reduction		1385.811	8.535		1330.384	15.5
Degrees of freedom		3	2		2	2
p value		.001	.001		.001	.001

Note: SES = socioeconomic status; *statistically significant effect at .05 level; **statistically significant effect at .01 level

TABLE 14

Parameter estimates (and standard errors) for the analysis of Science achievement of PISA 2015 and 2018, in Cyprus

	Year 2015			Year 2018		
	Model 0	**Model 1**	**Model 2**	**Model 0**	**Model 1**	**Model 2**
Fixed Part						
Intercept	411.82(5.10)**	428.11(3.49)**	426.81(3.61)**	432.16(5.65)**	441.71(3.96)**	440.79(4.03)**
Student Level						
Gender (0=girl, 1=boy)		-8.46(2.24)*	-8.11(2.22)*		-8.04(2.26)*	-7.73(2.26)*
SES		14.42(1.34)**	12.13(1.67)**		17.34(1.31)**	17.08(1.63)**
School level						
Average SES		57.24(5.84)**	54.62(5.92)**		66.09(8.71)**	63.24(8.39)**
Random Part						
Level 1 (student) random effects						
Intercept: $Var(R_{ijk}) = \sigma^2_{eo}$	6345.66(121.55)**	6242.10(120.63)**	6193.42(120.48)**	6659.72(127.98)**	6443.45(124.92)**	6404.70(124.83)**
Level 2 (school) random effects						
Intercept: $Var(U_{0k}) = \sigma^2_{u0}$	2771.04(404.01)**	938.38(157.43)**	986.20(166.99)**	2550.77(421.37)**	1022.47(183.26)**	1049.52(189.17)**
SES: $Var(U_{1k}) = \sigma^2_{u1}$			136.21(56.13)*			180.52(58.55)*
$Cov(U_{0k},U_{1k}) = \sigma_{v01}$			-73.43(33.25)*			-65.19(29.99)*
Significance Test						
Loglikelihood						
X^2	64900.332	63508.837	63496.252	64318.218	62953.326	62940.067
Reduction		1391.495	12.585		1364.892	13.259
Degrees of freedom		3	2		3	2
p value		.001	.001		.001	.001

Note: SES = socioeconomic status; *statistically significant effect at .05 level; **statistically significant effect at .01 level

TABLE 15

Parameter estimates (and standard errors) for the analysis of reading achievement of PISA 2015 and 2018, in Cyprus

	Year 2015			Year 2018		
	Model 0	**Model 1**	**Model 2**	**Model 0**	**Model 1**	**Model 2**
Fixed Part						
Intercept	418.65(5.90)**	454.08(4.09)**	453.30(4.20)**	416.27(5.85)**	439.73(4.23)**	438.78(4.29)**
Student Level						
Gender (0=girl, 1=boy)		-43.79(2.42)**	-42.64(2.42)**		-34.90(2.35)**	-34.41(2.35)**
SES		14.20(1.45)**	13.83(1.69)**		15.23(1.36)**	14.84(1.85)**
School level						
Average SES		65.19(6.78)**	63.79(6.86)**		60.47(9.29)**	59.76(9.09)**
Random Part						
Level 1 (student) random effects						
Intercept: $Var(R_{ijk}) = \sigma^2_{eo}$	7753.13(148.52)**	7292.72(140.96)**	7253.59(141.10)**	7418.22(142.74)**	6989.02(135.48)**	6922.81(134.98)**
Level 2 (school) random effects						
Intercept: $Var(U_{0k}) = \sigma^2_{u0}$	3752.72(542.54)**	1353.88(219.72)**	1414.57(231.08)**	2725.15(451.88)**	1177.96(209.83)**	1199.64(215.41)**
SES: $Var(U_{1k}) = \sigma^2_{u1}$			134.43(66.57)*			184.26(69.69)*
$Cov(U_{0k},U_{1k}) = \sigma_{v01}$			54.96(33.50)			-101.79(39.19)*
Significance Test						
Loglikelihood						
X^2	66027.374	64378.697	64370.847	64915.758	63397.157	63379.026
Reduction		1648.677	7.85		1518.601	18.131
Degrees of freedom		3	1		3	2
p value		.001	.001		.001	.001

Note: SES = socioeconomic status; *statistically significant effect at .05 level; **statistically significant effect at .01 level

To further examine the relation between the two dimensions of educational effectiveness (quality and equity) at the school level for each subject separately, we estimated the effectiveness status of each school participating in each PISA cycle in relation to each dimension of effectiveness. Tables 16 up to 21 present the distribution of schools in Cyprus in terms of their effectiveness status in terms of the quality and equity dimensions. The following observations arise from these tables. First, there is no school which is considered as most effective in terms of one dimension and as least effective in terms of the other dimension. Second, all six analyses reveal that the great majority of the schools that were considered as among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension. For example, Table 17 shows that 14 out of 20 schools found to be among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension. The other 6 schools were found to be among the typical in terms of the equity dimension. Third, all six analyses reveal that the majority of schools which were found to be among the least effective in terms of the quality dimension were also among the least effective in terms of the equity dimension. It can finally be argued that most schools were found to belong to the same category in terms of the two dimensions of effectiveness and the figures of Tables 16-21 seem to reveal a close relationship between quality and equity at the school level. One could therefore argue that the across country analyses of the two PISA cycles reveal a close relationship between the two dimensions of effectiveness at the country level whereas the analyses of Cyprus data seem to reveal that this relationship can also be found at the school level.

TABLE 16

The distribution of schools in Cyprus in terms of their effectiveness status in Mathematics in both quality and equity dimensions (Data from PISA 2015)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	12	2	0	14
Typical	7	80	7	94
Least Effective	0	5	11	16
Total	19	87	18	124

TABLE 17

The distribution of schools in Cyprus in terms of their effectiveness status in Science in both quality and equity dimensions (Data from PISA 2015)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	14	3	0	17
Typical	6	78	7	91
Least Effective	0	2	14	16
Total	20	83	21	124

TABLE 18

The distribution of schools in Cyprus in terms of their effectiveness status in Reading in both quality and equity dimensions (Data from PISA 2015)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	16	2		18
Typical	3	79	4	86
Least Effective	0	6	14	20
Total	19	87	18	124

TABLE 19

The distribution of schools in Cyprus in terms of their effectiveness status in Mathematics in both quality and equity dimensions (Data from PISA 2018)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	13	2	0	15
Typical	5	48	7	60
Least Effective	0	4	10	14
Total	18	54	17	89

TABLE 20

The distribution of schools in Cyprus in terms of their effectiveness status in Science in both quality and equity dimensions (Data from PISA 2018)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	11	3	0	14
Typical	5	50	6	61
Least Effective	0	5	9	14
Total	16	58	15	89

TABLE 21

The distribution of schools in Cyprus in terms of their effectiveness status in Reading in both quality and equity dimensions (Data from PISA 2018)

Quality / **Equity**	Most Effective	Typical	Least Effective	Total
Most Effective	16	2	0	18
Typical	6	39	7	52
Least Effective	0	5	14	19
Total	22	46	21	89

6. Concluding Remarks

The results of this study showed that there is a strong relationship between quality and equity at both the country and the school level. Different approaches were used to examine this argument not only across the participating countries but also within a specific country (i.e., Cyprus). The across country analyses showed that the achievement gap (in each subject) based on SES tends to be smaller in countries and schools which achieve better learning outcomes (quality dimension) after controlling for contextual factors, such as GDP. It is worth mentioning that GDP was found to have a significant effect on student achievement in each subject and therefore measuring the effectiveness status of educational systems should be done after controlling for the effect of GDP.

As regards the relationship between the two dimensions of effectiveness at the country level, it was also shown that there is almost no country which is considered as most effective in terms of one dimension and as least effective in terms of the other dimension and the great majority of the countries that were considered as among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension. In addition, when examining the changes in the effectiveness status of countries from 2015 to 2018, it was observed that there was no country which managed to improve its effectiveness status in terms of one dimension and at the same time decline its effectiveness status in terms of the other dimension. The same type of changes (i.e., improvement or stability or decline) in the effectiveness status in terms of the two dimensions are observed in a high percentage (i.e., 80%) of countries. As regards the relationship between the two dimensions of effectiveness at the school level, it was demonstrated from the analyses of data from the participation of Cyprus in the two cycles of PISA, that there is no school which is considered as most effective in terms of one dimension and as least effective in terms of the other dimension. The great majority of the schools that were considered as among the most effective in terms of the quality dimension were also found to be among the most effective in terms of the equity dimension.

These results show that there is no "cost" of promoting the one rather the other dimension and that the two dimensions of effectiveness cannot be treated as competing against each other. Consequently, countries and schools should try to increase their effectiveness in terms of not only quality but also equity, since policies and actions towards achieving greater equity among students will ultimately lead to higher learning outcomes as well (quality dimension). Countries and schools should provide increased learning opportunities to students who do not come from favourable backgrounds, so as to compensate for the original injustices these students may face (Charalambous et al. 2018; Kelly and Downey 2010) instead of providing the same learning opportunities to all students. Accordingly, this type of positive discrimination is not only considered by some as acceptable, but, in fact, essential to promote equity actively in schools, especially against the backdrop of international research evidence identifying relationships between student performance and socio-economic status (see Schleicher 2014). Therefore, schools comprised of students coming from disadvantaged backgrounds should treat issues of equity as a priority and aim to be involved in specialized school-based interventions to address both issues of quality and equity (Charalambous et al. 2018; Kelly 2012; Scheerens 2016).

Finally, the results of the present study on the relation between quality and equity within and across countries, can increase stakeholders' awareness about the importance of reducing the SES gap in student achievement. This is especially important in those countries and schools where final student learning results can be considered satisfactory, but SES still plays a very important role in achieving these results. Thus, the results of the present study may help policy makers

evaluate their own national policies on promoting quality and equity since they could investigate not only the extent to which students' mean performance has improved (quality) but also whether the SES gap in student achievement has been reduced (equity).

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