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What PISA 2015 results imply for policy

By reporting on the achievements of many education systems against a common set of benchmarks, PISA aims to encourage policy makers and practitioners to learn from the policies and practices of their peers around the world. This chapter examines how some of these policies and practices are associated with student outcomes, particularly those related to performance in and attitudes towards science.

A note regarding Israel

The statistical data for Israel are supplied by and under the responsibility of the relevant Israeli authorities. The use of such data by the OECD is without prejudice to the status of the Golan Heights, East Jerusalem and Israeli settlements in the West Bank under the terms of international law.



PISA conducts extensive, rigorous and internationally comparable assessments to measure the knowledge and skills of 15-year-old students. The PISA survey also gathers a wide range of data about students, parents, teachers, schools and education systems. The purpose of the assessments is to establish insights that help students learn better, teachers to teach better and school systems to become more effective. Because PISA reports on the achievements of many countries and economies against a common set of benchmarks, it stimulates discussion among key stakeholders in education in participating countries and economies about the strengths and weaknesses of their education systems; and it encourages policy makers and practitioners to learn about which education policies work best from the experiences of their peers around the world.

This volume describes the basic characteristics of schools and education systems, and examines the ways these characteristics are associated with education outcomes. These characteristics include, among others, the working conditions of teachers, the degree to which decisions are shared between different levels of government and school faculty, the frequency and nature of student assessments, how educational resources are allocated across schools, and how conducive the school climate is to learning. Education outcomes considered in PISA 2015 include students' academic performance, their belief in the value of scientific enquiry, their expectations of a career in science, and equity in science performance.

Everyone needs to be able to “think like a scientist” to a greater or lesser extent – to weigh evidence before coming to a conclusion, and understand that scientific “truth” can change over time, as new discoveries are made and as human understanding deepens. This volume describes the patterns of association between key school and system characteristics and students' proficiency in science, which varies considerably across education systems and schools.

While the causal nature of such relationships cannot be established from PISA results alone, an extensive network of correlations can be drawn between certain education outcomes and a large range of school- and system-level factors that could conceivably affect them. One such correlation that has been confirmed over successive PISA assessments is that greater spending on education is not always related to better results. Across those partner countries and economies that spend less per student compared to most OECD countries, greater expenditure is associated with higher PISA science scores (Figure II.6.2). But across those countries and economies that invest more than a threshold amount on education, and that includes most OECD countries, cumulative expenditure per student is no longer associated with student performance. This should prompt countries not only to think about the amount of resources invested in education, but also to carefully consider how these resources should be translated into quality education for all.

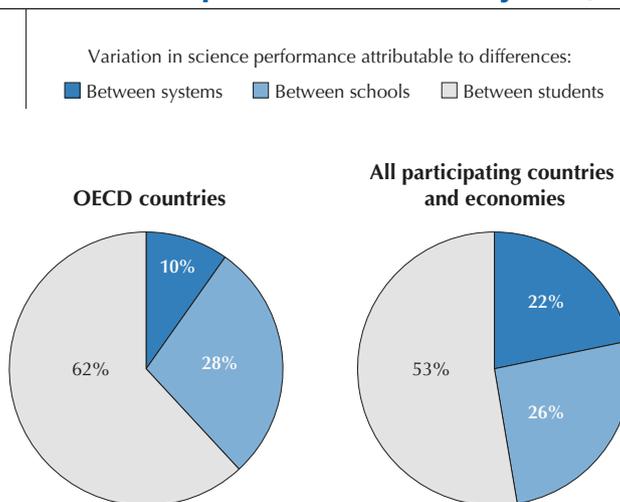
ACCOUNTING FOR VARIATIONS IN STUDENT PERFORMANCE

One of the main foci of this volume is to understand the differences in student outcomes between schools and education systems (Volume I examines student-level factors and Volume III explores social and emotional outcomes). Among OECD countries, 10% of the variation in science performance observed among students is attributable to differences in performance among school systems, 28% is attributable to differences in performance among schools within a country, and 62% is attributable to differences in performance among students within schools (Figure II.7.1). Across all the countries and economies that participated in PISA 2015, 22% of the variation in science performance is observed between school systems, 26% between schools, and the remaining between students.

GIVE EVERY 15-YEAR-OLD THE OPPORTUNITY TO LEARN SCIENCE IN SCHOOL

It may seem obvious to say that students need to learn science, but across OECD countries 6% of students reported that they are not required to attend any science lessons at school (Table II.2.3). Not surprisingly, these students score 44 points lower in science than students who attend at least one science course per week, and in 21 countries and economies, the difference is at least 50 points. Their poor performance may be one of the reasons why these students do not take science courses in the first place, but cutting them off entirely from school science may only widen the gap with their better-performing peers.

In many education systems where students are selected into different types of education programmes at an early age, such as Austria, Belgium, Hungary, the Netherlands and Switzerland, many 15-year-olds do not have access to science courses, or science competitions, at school. However, many 15-year-old students in other education systems also have no opportunity to learn science, in many cases because they are given some choice about the courses they attend. Even if all students do not have to learn the same science material, the opportunity to choose science courses need not become an opportunity not to learn science.

Figure II.7.1 ■ **Variation in science performance between systems, schools and students**

Source: OECD, PISA 2015 Database.

StatLink  <http://dx.doi.org/10.1787/888933436449>

All the correlational evidence in this volume suggests that learning science at school may be more effective than learning science outside or after school. Students who spend more time learning science at school score higher in science (Table II.6.33), while this is not necessarily the case with students who spend more time learning science after school (Table II.6.38). Students also score higher in science than in mathematics and reading when they spend more time learning science than learning mathematics and the language of instruction at school (Table II.2.29); but this is less true when students spend more time learning science, than learning mathematics and the language of instruction, after school. At the system level, students also score lower in science the more time they spend learning after school (Figure II.6.22).

After-school learning can also be inequitable. This is likely to be the case in education systems, like those in Croatia, Italy, Japan, Korea, Macao (China) and Chinese Taipei, where socio-economically advantaged students tend to spend more time than disadvantaged students learning after school (Table II.6.41). However, after-school study, such as in remedial programmes, can also help to close the performance gap between these two groups of students. To help make after-school learning opportunities more equitable, schools could consider making staff available to help students with homework at school, and providing a room where students can do homework (Table II.6.45).

Ensure that learning time is productive so that students can develop their academic, social and emotional skills in a balanced way

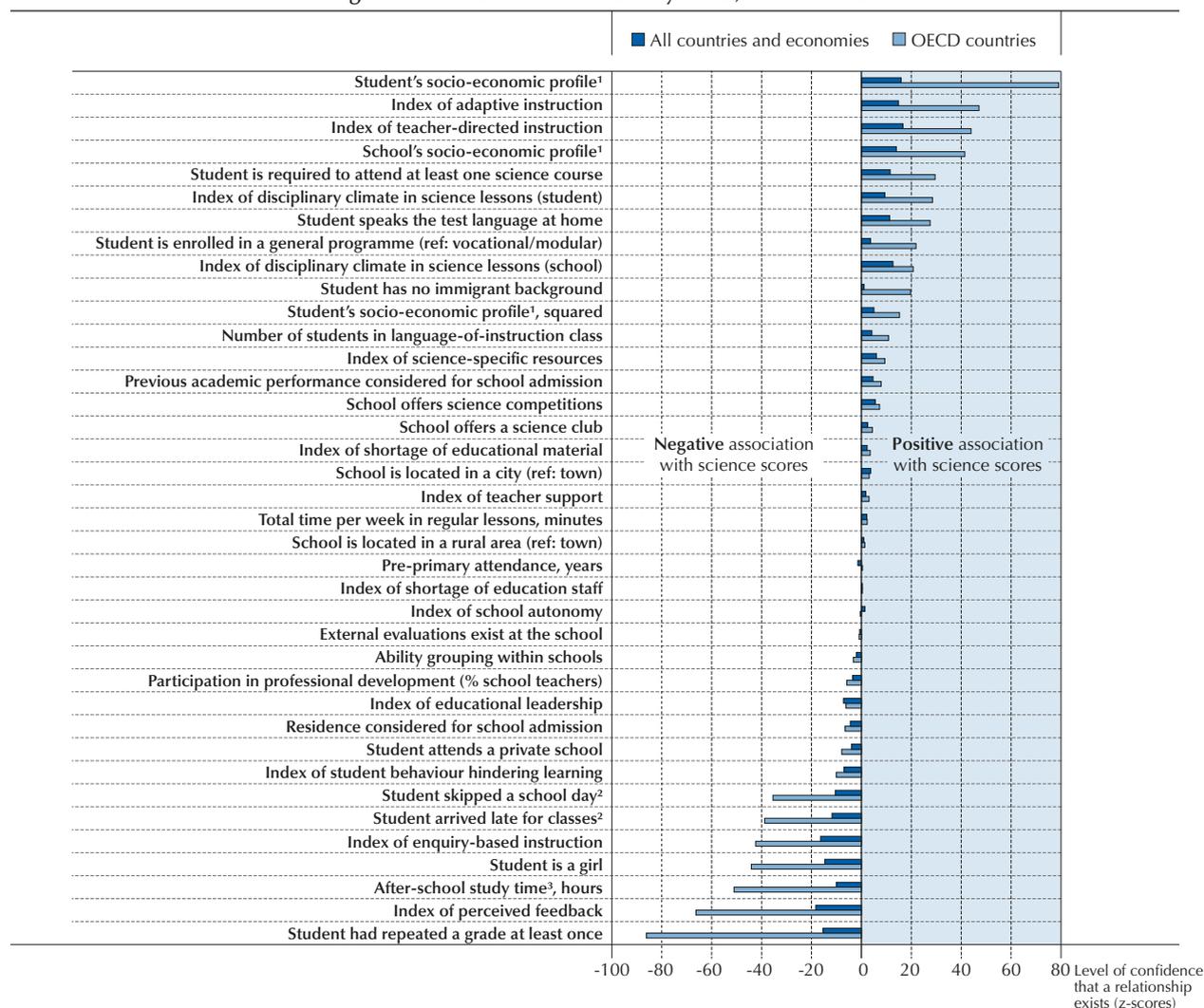
School systems differ widely in how much time students spend learning, particularly after school, and in how this learning time translates into academic performance. For instance, in Japan and Korea, students score similarly in science; however, in Japan, students spend about 41 hours per week learning (28 hours at school and 14 after school), all subjects combined, whereas in Korea they spend 50 hours (30 hours at school and 20 after school) (Figure II.6.23). In Tunisia and in Beijing-Shanghai-Jiangsu-Guangdong (China) (hereafter “B-S-J-G [China]”), students spend 30 hours per week learning at school, and 27 hours after school, but the average science score in B-S-J-G (China) is 531 points whereas in Tunisia it is 367 points. These differences may be indicative, among other things, of the quality of a school system, the necessity of combining learning time with effective teaching, or of whether students can learn informally after school.

Most parents would like to see their kids in schools where they can learn solid academic knowledge and skills but also have enough time to participate in non-academic activities, such as sports, theatre or music, that develop their social and emotional skills and contribute to their well-being. In this sense, Australia, the Czech Republic, Estonia, Finland, Germany, Japan, Macao (China), the Netherlands, New Zealand, Sweden and Switzerland provide a good balance between learning time and academic performance.

THE MOST AMBITIOUS EDUCATION REFORMS ASPIRE TO CHANGE WHAT HAPPENS INSIDE THE CLASSROOM

What happens inside the classroom is crucial for students' learning and career expectations. How teachers teach science is even more strongly associated with science performance and students' expectations of working in a science-related career than the material and human resources of science departments, including the qualifications of teachers or the kinds of extracurricular science activities offered to students (Figures II.2.21, II.2.22 and II.7.2). For instance, in almost all education systems, students score higher in science when they reported that their science teachers "explain scientific ideas", "discuss their questions" or "demonstrate an idea" more frequently (Table II.2.18). They also score higher in science in almost all school systems when they reported that their science teachers "adapt the lesson to their needs and knowledge" or "provide individual help when a student has difficulties understanding a topic or task" (Table II.2.24).

Figure II.7.2 ■ **Factors associated with science performance**
Multilevel regression models of education systems, schools and students



1. The socio-economic profile is measured by the PISA index of economic, social and cultural status (ESCS).

2. In the two weeks prior the PISA test.

3. Includes homework, additional instruction and private study.

Notes: All variables have been introduced jointly in a three-level regression model.

Statistically significant coefficients have associated z-scores below -1.96 or above 1.96.

The z-scores for «all countries and economies» are generally lower because the uncertainty surrounding the relationships is significantly higher.

See Table II.7.1. for results by education system.

Factors are ranked in descending order of the z-scores for OECD countries.

Source: OECD, PISA 2015 Database.

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Interestingly, students are more likely to expect to pursue a career in a science-related occupation when they perceive that their science teachers use a greater diversity of teaching strategies, regardless of which they are (Figure II.2.22).

While changing how teachers teach is challenging, school leaders and governments should try to find ways to make teaching more effective. For instance, in some education systems granting schools more autonomy over the curriculum may give teachers more opportunities to adapt their instruction to students' needs and knowledge (Figure II.2.17). In addition, teachers support their students more in countries and economies that separate their students later into different types of schools or education programmes.

Ensure that science laboratory work is meaningful

Experiments and hands-on activities can be inspiring and can help students develop a conceptual understanding of scientific ideas and transferable skills, such as critical thinking. However, the opportunity costs of these instructional methods can be high. Finding the right balance between different learning opportunities is therefore important. Moreover, in order for experiments and hands-on activities to be truly effective, school principals and teachers need to be prepared. Principals need to ensure that the laboratory material is in good shape and that teachers are supported and trained accordingly. Teachers need to design well-structured laboratory activities that make tangible key scientific concepts and ideas, and help students make the links between the hands-on activities, scientific ideas and real-life problems. Students should also be made aware that when participating in these activities, they are manipulating ideas as well as objects (Hofstein and Lunetta, 2004; Woolnough, 1991).

CREATE A POSITIVE LEARNING ENVIRONMENT FOR ALL

PISA shows that students tend to perform better in schools that provide an environment that is conducive to learning. However, the results suggest that learning environments across OECD countries have deteriorated in recent years: more students in 2015 than in 2012 reported that they had skipped a day of school or classes, or had arrived late for school in the two weeks prior to the PISA test (Table II.3.3); and principals were more likely in 2015 than in 2012 to report that teacher and student behaviours hindered student learning (Tables II.3.14 and II.3.19).

In a positive learning environment, everyone plays their part:

- Students attend school regularly, listen to the teacher, treat other students with respect, and do not disrupt the flow of instruction.
- Teachers co-operate by exchanging ideas or material and support their students by showing an interest in every student, providing extra help or giving students opportunities to express their ideas.
- The school principal ensures that children with different abilities and from different backgrounds are given the same opportunities to learn, reacts swiftly when behavioural and academic problems arise, and ensures that a range of extracurricular activities are offered at school.
- Parents participate in a range of school activities, not only when their child has behavioural or academic problems, and interact with other parents.
- Governments use assessments and information systems, already in place in most countries and economies, and informal mechanisms to identify individual schools that are struggling with student-behaviour problems and may need special assistance.

ENCOURAGE SCHOOLS TO USE MULTIPLE TYPES OF ASSESSMENTS

Student assessments serve different purposes, and some assessments are better suited to achieving some goals than others. For instance, standardised tests seem to be used most commonly for comparing schools, awarding certificates to students or monitoring a school's progress from year to year, whereas teacher-developed tests tend to be used more frequently for informing parents about their child's progress, identifying aspects of the instruction that could be improved or guiding student learning (Figures II.4.24 and II.4.25). It is important to combine multiple types of assessments strategically, including traditional written exams designed by teachers, oral tests, teachers' judgements, collaborative problem solving, long-term projects or standardised tests, so that a wide variety of education goals can be fulfilled and students can develop the skills they need for the future (OECD, 2013a). School leaders and teachers should be prepared to design and grade their own assessments, provide fair and balanced judgements, and be comfortable with conducting and interpreting standardised tests.



The PISA test, itself, offers some guidance for schools and teachers (OECD, 2016):

- Develop balanced assessments. In addition to using multiple types of assessments, schools and teachers should ask questions in different formats (e.g. open-ended or multiple choice), of varying levels of difficulty, that are set in various contexts (e.g. personal, social, global, occupational) and cover the range of skills for a “typical” student.
- Design assessments strategically. For instance, tests can start with easy questions, so that students gain confidence, and leave the most challenging topics for the end.
- Focus on students’ abilities and skills. When assessing students, it is always worth asking what type of skills will students need to lead a successful life.
- Be fair. Assess students in ways that are fair and inclusive for everyone, regardless of gender, socio-economic status or ability.
- Innovate. New types of assessments are constantly being developed around the world, with varying degrees of success. Learn about them by talking to colleagues, participating in innovation networks or researching the web. For instance, reading the PISA assessment questions made public might give some ideas to governments, schools and teachers about how to design assessments.

BUILD A SKILLED AND DEDICATED TEACHER WORKFORCE

Most policy interventions that aspire to have an impact on student learning, such as by changing classroom dynamics or creating a positive learning environment, depend on teachers for their success. The most successful education systems select and retain highly qualified candidates for the teaching profession and ensure that they are constantly improving.

Attract and retain qualified teachers, and ensure that they continue to learn throughout their careers

To build a skilled and effective teacher workforce, school systems need to attract talented graduates into the teaching profession and retain teachers who are skilled, dedicated and effective. In the school systems that have been more successful in attracting and retaining qualified teachers, the following typically happens (OECD, 2014):

- Education and the teaching profession are greatly valued by society.
- Teachers are adequately compensated.
- The teaching career is transparent and clearly structured, and the recruitment process for entering the teaching profession is fair and rigorous.
- Teachers are given many opportunities to learn. Offering professional development activities in-house, for instance by organising workshops or inviting specialists to the school, can be a very effective way of engaging teachers (Table II.6.25). Teachers are also encouraged to participate in professional development communities and co-operate with their colleagues. This can create a stimulating learning environment from which students can benefit greatly (Table II.6.21).
- Teachers receive feedback on their teaching regularly, such as through mentoring programmes organised by schools.

BALANCE SCHOOL AUTONOMY WITH ACCOUNTABILITY, AND DEVELOP CAPACITY AT THE LOCAL LEVEL

In the past decades, a number of changes have occurred in how school systems allocate school-management responsibilities to various actors. While some countries have decentralised decision making related to school operations, giving local actors, such as principals and teachers, more responsibility over a range of budgetary, operational and instructional issues, in other countries, education authorities at the local, regional and national levels gained more control over these matters. The latest results show that, compared to 2009, fewer school principals in 2015 hold considerable responsibility for the school budget, the hiring of teachers or the courses offered at school (Table II.4.4). Principals and teachers are also less responsible for school policies related to assessment, disciplinary actions and school admissions.

Giving schools greater control over these matters has been advocated on the grounds that local actors understand their students’ needs better than higher administrative bodies, and thus can make better decisions to improve their students’ outcomes (Caldwell and Spinks, 2013; Department of Education, 2010). PISA 2015 offers a nuanced picture of the relationship between greater school autonomy and students’ performance, which seems to depend not only on the particular areas of school management delegated to principals and teachers, but also on how these areas are related to certain accountability measures and to the capacity of local actors.



In particular, students score higher in science when principals exercise greater autonomy over resources, curriculum and other school policies, but especially so in countries where achievement data are tracked over time or posted publicly more extensively or when principals show higher levels of educational leadership (Figures II.4.8 to II.4.13). These findings highlight the interplay between school autonomy and accountability already identified in earlier PISA assessments. When principals lack the preparation and capacity to exercise leadership, transferring authority to schools may inadvertently work against students, since school staff might then be deprived of the resources and expertise available at higher levels of the system. Students also score higher in science in countries where more teachers have autonomy over the curriculum. This finding underscores the importance of tapping into teachers' expertise. Teachers can not only help design and implement rigorous curricula, but they can also adapt content to students of varying ability.

STRIVE TO HAVE EXCELLENT SCHOOLS IN EVERY NEIGHBOURHOOD AND MAKE THEM ACCESSIBLE TO ALL STUDENTS

Some countries, such as the Netherlands and the United Kingdom, have a strong tradition of offering an extensive choice of schools to parents. But in many other education systems, the issue of school choice and competition can be controversial. Advocates of market-based models argue that giving more school choice to parents can improve the quality of education overall, so that, in the end, all parents and students benefit from better schools (Card, Dooley and Payne 2010; Woessmann et al., 2007). But this argument is challenged by those who say that advantaged families might move their children to better schools, resulting in less – and perhaps poorer quality – material and human resources being allocated to neighbourhood public schools, especially if school funding is linked to enrolment (Behrman et al., 2016; Ladd, 2002; Valenzuela, Bellei and Rios, 2014).

In a majority of countries/economies, competition among schools is positively associated with science performance at the school level (Table II.4.14), but school competition does not benefit everyone to the same extent. PISA 2015 shows that in most of the 18 education systems that distributed the parents' questionnaire, more schools are available to families whose children attend advantaged and urban schools than to those whose children are enrolled in disadvantaged and rural schools. Increasing school competition is difficult in some situations, such as in rural areas, and healthy competition implies that parents are well-informed about the options available to them and can choose a school without financial constraints. While parents from all backgrounds cite school reputation as an important consideration when choosing a school for their child, disadvantaged parents are much more likely than advantaged parents to report that they consider "low expenses" to be an important factor when choosing a school (Figures II.4.17 and II.4.18). Allowing parents to choose their child's school can open up a world of opportunities if all families can choose on an equal basis; if not, a world of inequalities can be the result instead.

In most school systems, disadvantaged students are more likely to attend public schools than advantaged students. It is therefore not surprising that across OECD countries, students enrolled in private schools perform better in science than students in public schools (Figures II.4.14). But when students and schools have a similar socio-economic profile, the "advantage" of private schools disappears, except in a handful of countries, and students in public schools in about one in three education systems score higher in science. In other words, the performance advantage of private schools tends to reflect either the more privileged home background of students and their families, or the fact that more privileged students tend to be enrolled in schools with a better instructional climate or better educational resources. PISA shows no clear association between the percentage of students enrolled in public and private schools and a school system's average performance in science (Figure II.4.15).

Nurturing academic excellence for all students might then entail having excellent schools easily accessible in every neighbourhood, providing adequate transportation and reducing the financial burden on parents, particularly those in low-income areas. In systems that offer choice, creating or improving websites or other information systems that provide parents with clear information about schools in their area – such as the schools' academic performance, graduation rates and admissions policy – can be one way to help them navigate the full range of choices available to them. Increasing opportunities for face-to-face discussions between the school community and parents of prospective students, such as open-door events, can also help bridge the information gap between advantaged and disadvantaged families if well planned. Providing incentives for schools, including private schools, to increase the social diversity of their student body might help make the schools more welcoming to all families.



ADJUST THE SIZE OF SCHOOLS AND CLASSES IF FINANCIAL RESOURCES ARE LIMITED

Evidence presented in the volume (Tables II.6.7 and II.6.8) shows that the relationship between school size and student outcomes is not clear-cut. Across OECD countries, students in larger schools score higher in science and are more likely to expect to work in a science-related career than students in smaller schools. But students in smaller schools reported a better disciplinary climate in their science lessons, and they are less likely than students in larger schools to skip days of school and arrive late for school, after accounting for socio-economic status. Previous research also shows ambiguous findings, such that the effect of school size varies across student groups and levels of education, and often changes after certain thresholds are crossed (Box II.6.1). Because deciding the optimal size of schools based on student outcomes alone is not straightforward, the decision should be based to a great extent on financial considerations. Running larger schools, which can benefit from economies of scale, is usually more efficient than running small schools. However, above a certain size there may be negative returns to expansion (Box II.6.1), and sometimes, particularly in rural areas, it might be impossible to increase the number of students in schools without forcing students to endure long commutes or enrolling them in boarding schools.

Even if previous research has pointed to some benefits associated with smaller classes, particularly for disadvantaged and minority students (Dynarski, Hyman and Schanzenbach, 2013), PISA data show that large classes have not prevented schools in East Asia from providing good instruction (II.6.16), and that, across OECD countries, students in large classes tend to score higher (Table II.6.30). Given the high costs associated with smaller classes, governments should seriously consider the opportunity costs of reducing class size.

FAVOUR ADDITIONAL SUPPORT TO STRUGGLING STUDENTS RATHER THAN GRADE REPETITION.

What is the best way of helping struggling students? Retaining students in the same grade for an additional year may be a popular idea among policy makers and educators in many countries, but a growing body of research points to the negative consequences of grade repetition. Students who have repeated a grade tend to display more negative behaviours and attitudes towards school, are more likely to drop out and may be stigmatised among their classmates (Ikeda and García, 2014; Rumberger and Lim, 2008; Thompson and Cunningham, 2000; West, 2012). Previous PISA findings have already revealed that at the system level, higher rates of grade repetition are associated with lower performance in mathematics and lower levels of equity (OECD, 2013b). PISA 2015 results also show that in education systems where grade repetition is used more extensively, overall science performance is lower and equity is compromised (Figure II.5.4 and Figure II.5.13). From the perspective of an education system as a whole, grade repetition is also a costly policy, requiring an additional year of spending per student with no guaranteed results. In some countries that practice grade repetition, such as Belgium and the Netherlands, the additional cost per repeater can be as high as USD 48 900 or more. And the total cost of grade repetition can represent 10% or more of these countries' annual national expenditure on primary and secondary education (OECD, 2013b).

Fortunately, there has been notable progress on this front. Between 2009 and 2015, grade repetition rates in 30 countries dropped – and by at least 10 percentage points in Costa Rica, France, Indonesia, Latvia, Macao (China), Malta, Mexico and Tunisia (Table II.5.11). In fact, France reduced its grade repetition rate by 16 percentage points during this period while maintaining OECD average levels of performance in science in 2015. Further improvement can be achieved in many countries, especially among subgroups of students that seem to be unfairly targeted for grade repetition. Across OECD countries, boys, disadvantaged students and those with an immigrant background are significantly more likely to have repeated a grade at least once in primary or secondary school, even when they perform similarly and have similar motivation and attitudes towards learning as their peers who had not repeated a grade (Table II.5.13). These findings clearly show that grade repetition is a costly policy that is applied in ways that are neither objective nor equitable in many school systems.

It may be difficult for school systems to identify those cases where students are retained unfairly, so setting ambitious goals to reduce the use of such practices throughout the system may help limit abuses. But struggling students still need support. Additional guidance and learning time inside or outside of school, accompanied by the establishment of clear, challenging and achievable goals can help. Curricula are usually designed to be followed by all students. But designing individualised learning plans may allow students who are struggling to learn the material and to progress at their own pace, ultimately meeting the standards set for all students, but over a longer period of time.



DELAY THE AGE AT SELECTION INTO DIFFERENT EDUCATION PROGRAMMES

Countries that offer a variety of education programmes as part of compulsory education, such as general/academic, pre-vocational, vocational or technical programmes, are probably familiar with research evidence showing that sorting students into different tracks may exacerbate social and economic segregation and increase inequality (Hanushek and Woessmann, 2005; Maaz et al., 2008). These concerns are justified, as disadvantaged students tend to be disproportionately represented in vocational programmes (Figure II.5.9).

PISA results show that the age at which students are streamed into various tracks is associated not only with greater performance discrepancies between schools (low academic inclusion), but also with less equity in science performance (Figures II.5.11 and II.5.13). In short, in countries where students are sorted into tracks at an early age (early tracking), the socio-economic status of students has a greater impact on students' scores in science compared with countries where tracking is delayed to a later age.

Why do systems that delay the age of tracking tend to have more equitable outcomes? Is selection into different programmes subject to teachers' biases? Are vocational programmes under-resourced compared to general programmes? Is early selection limiting the learning opportunities and career choices of "late bloomers"? Do students in some tracks lack the kind of social, academic and cultural diversity that makes for a stimulating learning environment? Although PISA data do not allow for an investigation into the underlying causes behind these differences, the findings on system stratification provide some insights into some factors that countries may wish to consider when confronted with the challenge of reducing inequalities among schools and students.

Providing a challenging and rich curriculum in all tracks; delaying the age at selection into different programmes; introducing flexibility into the system so students can transfer between programmes; and offering pathways to higher education to all students are just some of the ways that countries can mitigate undesirable consequences of early tracking.

PROVIDE ACCESS TO QUALITY EARLY EDUCATION FOR ALL CHILDREN

PISA shows that, across OECD countries, students who had attended pre-primary school tend to perform better at the age of 15 than students who had not attended, even after accounting for students' socio-economic status (Table II.6.52). It is not possible to ascertain, though, whether this is an effect of the learning opportunities provided in early childhood education or simply mirrors selection. The data also show that many students had attended pre-school for less than one year, and in almost every school system, these students are more likely to be disadvantaged (Tables II.6.50 and II.6.51). In Croatia, the Dominican Republic, Lithuania, Montenegro, Portugal and Turkey, for instance, at least one in five students had attended pre-primary school for less than a year. Providing access to early education for all children can be accomplished by passing legislation that gives every child the right to participate in pre-primary education, by developing or subsidising a network of free pre-primary education centres to ease the financial burden on disadvantaged families, and by providing information and guidance to parents.

ABOVE ALL, PROVIDE ADDITIONAL SUPPORT TO DISADVANTAGED SCHOOLS

Achieving equity in education means ensuring that students' socio-economic status has little to do with learning outcomes. Learning should not be hindered by whether a child comes from a poor family, has an immigrant background, is raised by a single parent or has limited resources at home, such as no computer or no quiet room for studying. Successful education systems understand this and have found ways to allocate resources so as to level the playing field for students who lack the material and human resources that students in advantaged families enjoy. When more students learn, the whole system benefits. This is an important message revealed by PISA results: in countries and economies where more resources are allocated to disadvantaged schools, overall student performance in science is somewhat higher (Figure II.6.4).

PISA data uncover a number of differences between disadvantaged and advantaged schools, both quantitative and qualitative, that collectively paint a picture of the drastically different learning environments in these distinct types of schools. Disadvantaged schools have fewer qualified science teachers and are less likely to require students to attend science classes (Tables II.2.3 and II.2.6). Their students not only spend less time in regular lessons than students in advantaged schools (Table II.6.36), they are also less exposed to quality teaching. For example, teachers in their schools are less likely to engage in some effective teaching strategies, such as explaining or demonstrating a scientific idea (Table II.2.17). The range of learning opportunities beyond regular classes is also much narrower in disadvantaged schools, as these schools tend to offer fewer extracurricular activities, such as science competitions and clubs, sports, and music



and arts activities (Tables II.2.12, II.2.13 and II.6.49). Disadvantaged schools also tend to be subject to more disciplinary problems and a lack of student engagement, manifested in students arriving late for school or skipping days of school, which compromise students' opportunities to learn and to do well in school (Tables II.3.4, II.3.6 and II.3.11). Some of these differences between disadvantaged and advantaged schools are magnified in countries that practice early tracking.

Compensatory measures are essential and, in many ways, they are already in place in various countries. But further steps need to be taken. For example, it is not enough for disadvantaged schools to have more computers per student; these computers need to be connected to the Internet and, more important, they need to be used in a way that improves learning, not distracts from it. It is not enough for students in these schools to spend more time studying after school; they also need more time in regular lessons with better teaching, which is what their counterparts in advantaged schools already have. And they need more support after class, too, in the form of tutoring, and in enriching extracurricular activities.

PISA findings help countries identify some of these deficiencies, but policy makers are left with the hard work of finding the best ways to address them. Solutions will vary depending on the nature of the gaps. For example, in some education systems, like those in Ciudad Autónoma de Buenos Aires (Argentina), Georgia, Lebanon, Macao (China), Mexico or Thailand, policy makers might try to achieve a better distribution of material resources. In others, such as Australia, B-S-J-G (China), New Zealand, Spain or Uruguay, a better allocation of human resources seems to be a priority.

Even when different schools face similar problems, tailored solutions that capitalise on assets already in place may be needed; and progress towards learning goals should be continuously monitored. Countries should also watch for practices that could undermine the equity of their system. For example, in countries and economies where students in advantaged schools spend more time studying after school, such as Croatia, Italy, Japan, Korea, Macao (China) and Chinese Taipei, the performance disparities between disadvantaged and advantaged schools may well increase. Governments may need to provide additional resources for free-of-charge tutoring in disadvantaged schools so as to prevent the development of a shadow education system – and to ensure equity in education opportunities.



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