3

Trends in Mathematics and Science

Changes in mathematics and science performance are smaller than those in reading, since performance in these two subjects is measured over a shorter period of time. This chapter describes trends in mathematics performance between 2003 and 2009, and trends in science performance between 2006 and 2009.

TRENDS IN MATHEMATICS

How student performance in mathematics has changed since 2003

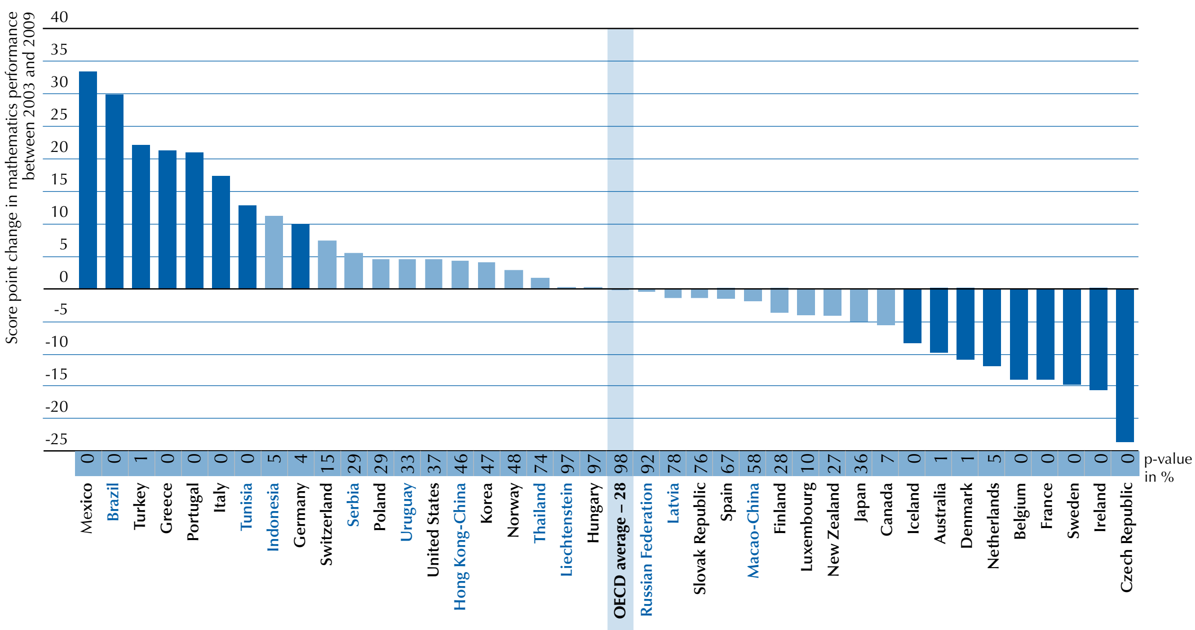
Trends in performance in mathematics are derived by comparing results from PISA 2009 with those from the 2003 and 2006 assessments. Since trends in mathematics start in 2003, as opposed to trends in reading, which start in 2000, performance changes in mathematics since 2003 are expected to be smaller than performance changes in reading since 2000. PISA 2003 provides results in mathematics that were measured with more precision than in PISA 2006 and PISA 2009, since the latter two surveys devoted less assessment time to mathematics. Thus, trends in mathematics are not discussed in as much detail as the results for reading. The PISA 2003 mean score for mathematics for OECD countries was set at 500 and the standard deviation was set at 100, establishing the scale against which mathematics performance in PISA 2009 is compared. Most results in mathematics presented in this section discuss the difference between 2003 and 2009 assessments.

In terms of the OECD average, mathematics performance remained unchanged between 2003 and 2009 (Table V.3.1). However, several countries show marked changes in mathematics performance.

Students in 8 of the 39 countries with comparable results in both the 2003 and 2009 assessments show improvements in mathematics performance. This includes 6 out of the 28 OECD countries with valid data for both assessments. Students in Mexico improved their performance by 33 score points; students in Turkey, Greece and Portugal by more than 20 score points; and students in Italy and Germany by 17 and 10 score points, respectively. Among partner countries and economies, students in Brazil improved their performance by 30 score points, while students in Tunisia scored 13 score points higher (see Box V.G on Brazil).

In nine countries, mathematics performance in 2009 was significantly lower than in 2003. In the Czech Republic, students' scores decreased by 24 score points. In Ireland, Sweden, France, Belgium, the Netherlands and Denmark, students' scores in mathematics decreased by between 11 and 16 score points. In Australia student scores decreased by 10 score points, and in Iceland they decreased by 8 score points.

■ Figure V.3.1 ■
Change in mathematics performance between 2003 and 2009



Note: Statistically significant score point changes are marked in a darker tone.
Countries are ranked in descending order of the score point change on the mathematical scale between 2003 and 2009.
Source: OECD, *PISA 2009 Database*, Table V.3.1
StatLink http://dx.doi.org/10.1787/888932359986

In 22 countries, performance in mathematics remained unchanged between 2003 and 2009, when considering a 95% confidence level. For those countries where the changes are not statistically significant, Figure V.3.1 provides the p-value, which allows the reader to interpret the score point differences.

Even countries that show improvements in mathematics performance can still perform below the OECD average, while those that show a decline in performance can continue to outperform others. Examined together, performance levels and trends provide a fuller picture of how student performance has evolved.

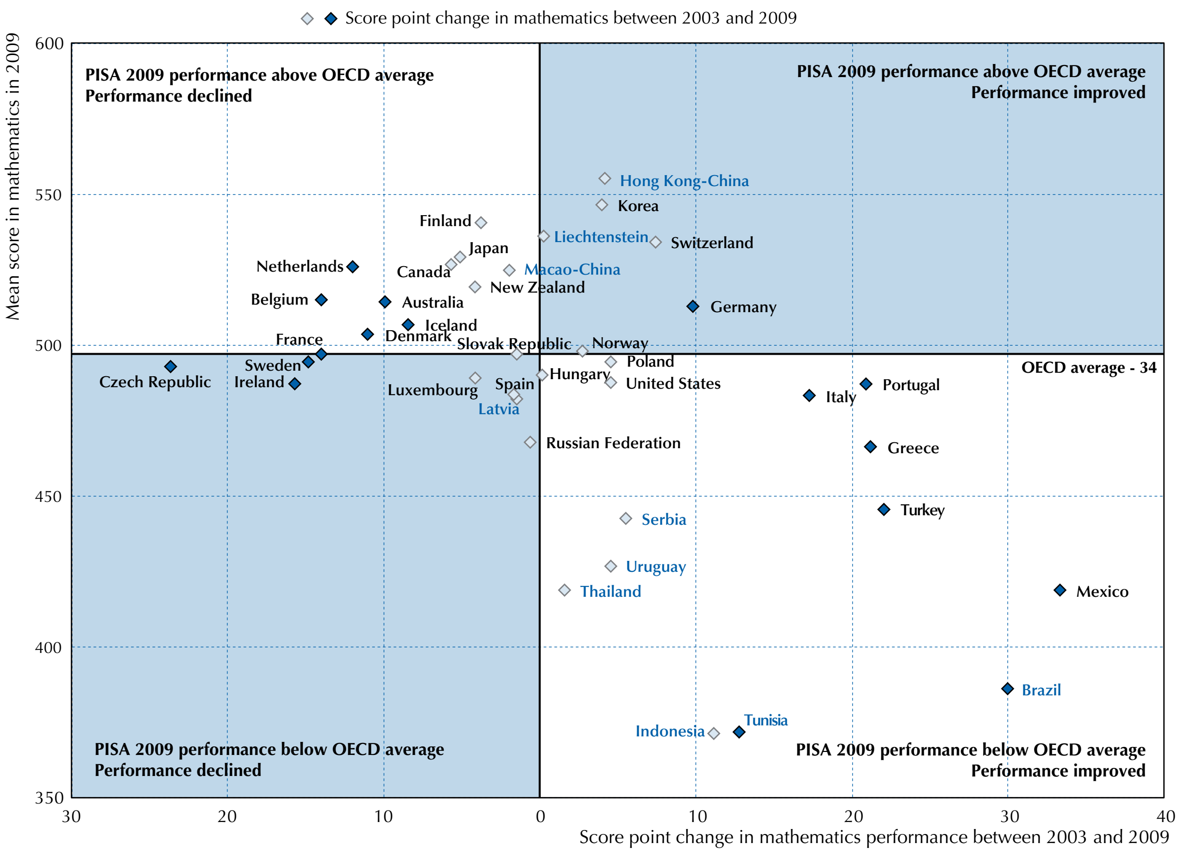
The relative standing of countries according to their mean performance in mathematics and the observed changes in mathematics performance are shown in Figure V.3.2. Countries towards the right side improved their performance since 2003, while those towards the left side showed a decrease in student scores. Countries towards the top end of the figure performed above the OECD average in 2009, while those towards the bottom end performed below the OECD average. A more detailed interpretation of this figure is given in Chapter 2 as it applies to Figure V.2.2.

None of the top-performing countries increased their scores in mathematics, and none of the lowest-performing countries saw a decline in their performance. In fact, seven out of the eight countries showing a significant improvement scored below the OECD average, both in 2003 and in 2009, while those showing a decline all started off with average or above-average mean scores.

Germany performed close to the OECD average in 2003, increased its performance by 10 score points between 2003 and 2009, and now performs above the OECD average. Portugal and Italy, which both scored 466 score points in 2003, increased their performance by 21 and 17 score points, respectively, and are now much closer to the OECD average (see Box V.D on policies implemented in Portugal).

■ Figure V.3.2 ■

How countries perform in mathematics and how mathematics performance has changed since 2003



Note: Score point changes in mathematics between 2003 and 2009 that are statistically significant are marked in darker tone.
Source: OECD PISA 2009 database, Table V.3.1
StatLink http://dx.doi.org/10.1787/888932359986

The remaining five countries that performed below average in 2003 and improved their performance by 2009 showed a wide range in their mean scores. Mexico, the country with the largest improvement, increased student scores by 33 score points. While it now performs above 400 score points, it is still far below the OECD average. Turkey and Greece increased their performance by slightly more than 20 score points, now scoring at 445 and 466, respectively. Among partner countries, Brazil increased its performance in mathematics by 30 score points, and Tunisia by more than 10 score points. Yet both countries still perform below 400 score points.

A number of countries that score above the OECD average show a decline in mathematics performance but still outperform many others. In the Netherlands, student scores decreased by 12 score points, but the Netherlands is still among the top-performing countries in PISA. Student scores in Belgium, Denmark, Australia and Iceland decreased by around 10 score points, and these countries now score closer to the OECD average albeit above it.

Several countries that performed above the OECD average in mathematics now score at or below the average level. The Czech Republic scored above the OECD average in 2003, but because of a decrease of 24 score points, it now scores slightly below the OECD average. France and Sweden both declined in performance and moved from the group of countries performing above the OECD average to the OECD average.

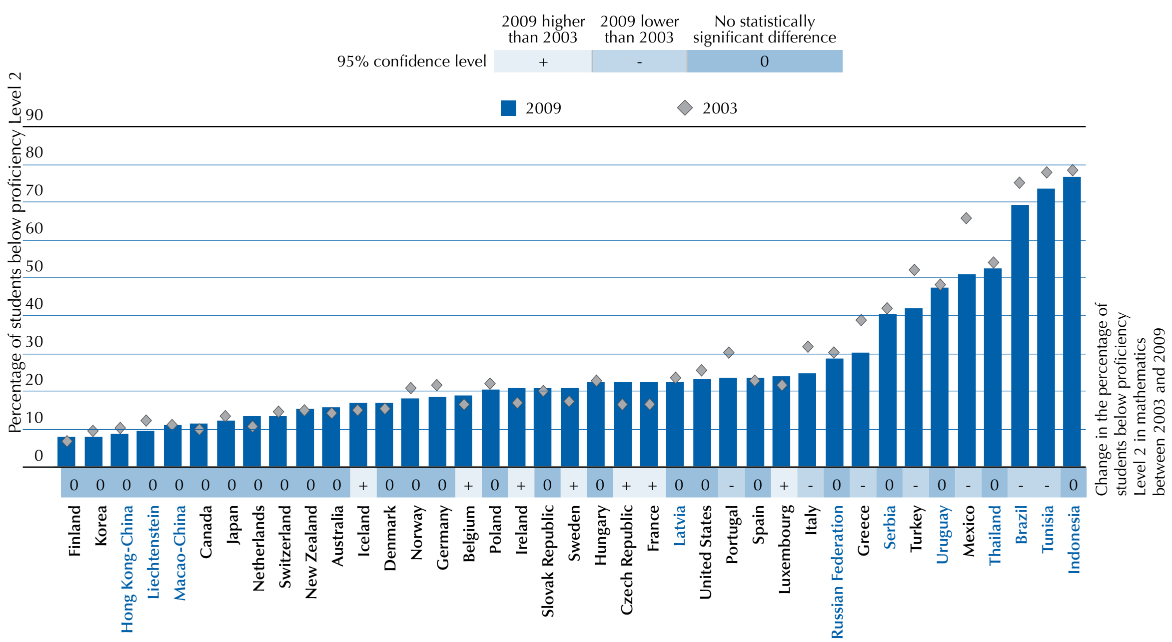
Changes in mean mathematics achievement describe overall trends, but can mask changes among the lowest- and the highest-achieving students. These can be analysed by looking at changes in the proportion of students reaching certain proficiency levels. As described in Chapter 2 for reading, for the purpose of these analyses, students below Level 2 were combined into a single category of lowest performers, while those at Level 5 or above were combined into another category of top performers. Changes in percentages in both categories were compared between 2003 and 2009.

The proficiency levels used in the PISA 2009 mathematics assessment are the same as those established for mathematics when it was the major area of assessment in 2003. The process used to produce proficiency levels in mathematics is similar to that used to produce proficiency levels in reading, as described in detail in Volume I, *What Students Know and Can Do*.

On average across the 28 OECD countries with comparable data for the 2003 and 2009 assessments, the share of students below Level 2 remained broadly similar, with a minor decrease from 21.6% to 20.8% (Table V.3.2).

■ Figure V.3.3 ■

Percentage of students performing below proficiency Level 2 in mathematics in 2003 and 2009



Countries are ranked in ascending order of the percentage of students below proficiency Level 2 in mathematics in 2009.
Source: OECD, *PISA 2009 Database*, Table V.3.2

StatLink http://dx.doi.org/10.1787/888932359986

A corrigendum has been issued for this page. See: http://www.oecd.org/dataoecd/43/61/49198566.pdf

Among the OECD countries in which more than half of students performed below Level 2 in 2003, this proportion decreased by 15 percentage points in Mexico, from 66% to 51%, while Turkey saw a 10 percentage point reduction, from 52% to 42% (see Box V.E on policies aimed at low-performing students in Turkey). In Greece, Italy and Portugal the percentage of lowest performers decreased by considerably less than in the countries mentioned above, but all these countries now all show 30% or less of these students. This percentage decreased in Greece from 39% to 30%, in Italy from 32% to 25%, and in Portugal from 30% to 24%. Two partner countries with a large share of lowest performers, Brazil and Tunisia, have seen a reduction in the proportion by four to six percentage points, but still show around 69% and 74% of students are not proficient at Level 2 in mathematics. None of the countries with a below-average share of lowest performers saw further reductions in this percentage.

The share of students performing below Level 2 increased in France, the Czech Republic, Ireland, Sweden, Belgium, Luxembourg and Iceland (Figure V.3.3).

On average across the 28 OECD countries with comparable data for the 2003 and 2009 assessments, the percentage of top performers decreased slightly from 14.7% in 2003 to 13.4% in 2009 (Table V.3.2).

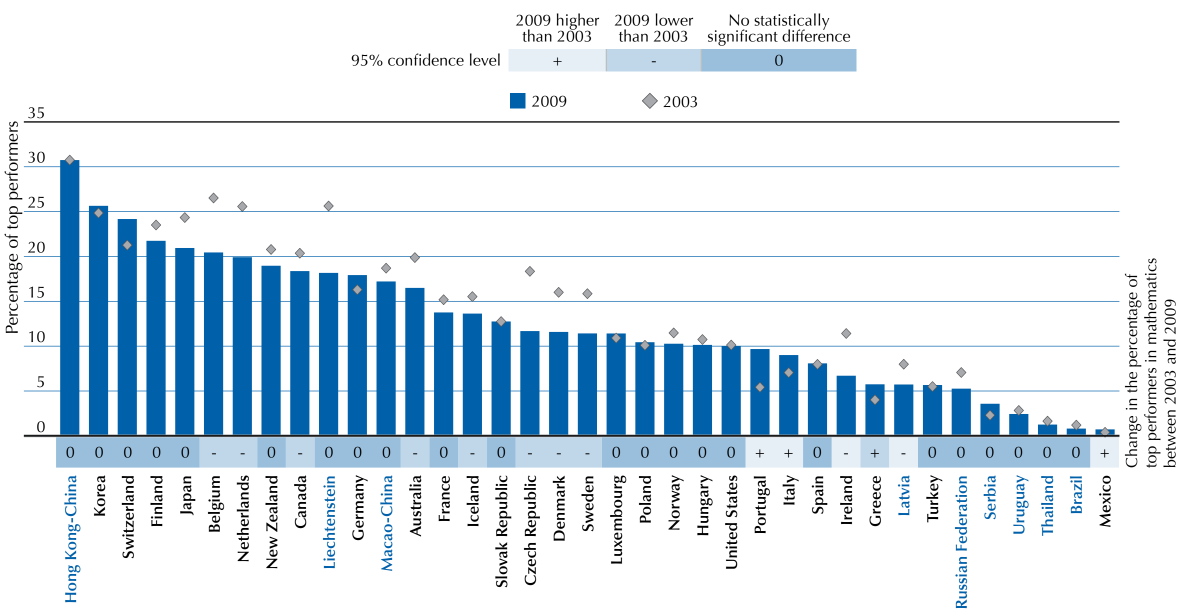
Among countries where the percentage of students performing at Level 5 or above was below the average, Portugal saw an increase in this percentage by more than 4 percentage points to almost 10%, Italy by nearly 2 percentage points to 9%, and Greece by less than 2 percentage points to nearly 6%. This proportion increased by 0.3 percentage points in Mexico but remained at a low 0.7%. In 2003, Ireland and the partner country Latvia had shares of top performers below the OECD average. This proportion decreased in both countries: by nearly 5 percentage points in Ireland, to less than 7%, and by 2 percentage points in Latvia, to less than 6%.

Among countries that had an above-average share of top performers in mathematics in 2003, none saw a further increase in this share. The share decreased by almost seven percentage points in the Czech Republic, by six percentage points in Belgium and the Netherlands, by four percentage points in Denmark and Sweden, by three percentage points in Australia, by two percentage points in Canada, and by nearly two percentage points in Iceland (Figure V.3.4).

Mathematics performance can be annualised the same way that reading performance can. Those results can be compared with annualised results in reading or science to see how the magnitude of change differs across the three assessment areas. The annualised results are provided in Table V.3.3 together with additional comparisons of changes in mathematics performance between 2006 and 2009.

■ Figure V.3.4 ■

Percentage of top performers in mathematics in 2003 and 2009



Countries are ranked in ascending order of the percentage of students at proficiency Level 5 or above in mathematics in 2009.
Source: OECD, *PISA 2009 Database*, Table V.3.2

StatLink http://dx.doi.org/10.1787/888932359986

TRENDS IN SCIENCE

How student performance in science has changed since 2006

Trends in science performance are derived by comparing results from PISA 2009 with those from the PISA 2006 assessment. Since the trends in science start from 2006, as opposed to the trends in reading, which start from 2000, performance changes in science since 2006 are expected to be smaller than performance changes in reading since 2000, and smaller than performance changes in mathematics since 2003. The 56 participants in PISA 2006 also took part in PISA 2009, with comparable results, including 33 OECD countries. The PISA 2006 mean for OECD countries was set at 500 and the standard deviation was set at 100, establishing the scale against which science performance in PISA 2009 is compared.

The OECD average in science performance remained unchanged between 2006 and 2009. However, as shown in Figure V.3.5, several countries showed marked changes in science performance (Table V.3.4).

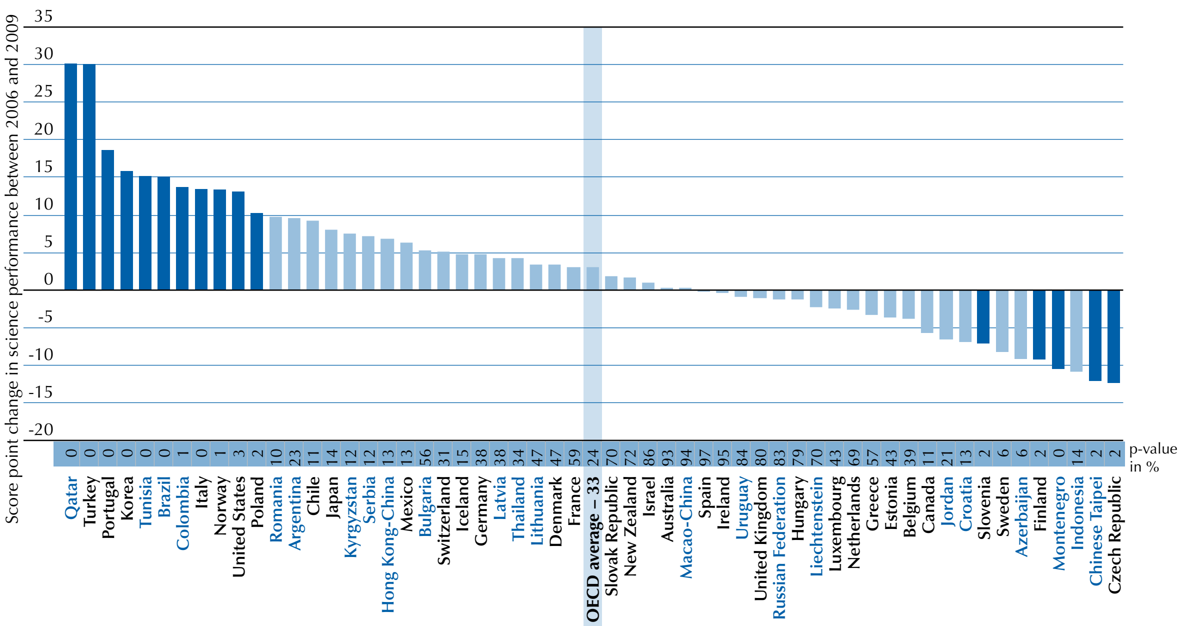
Eleven of the fifty-six countries that have comparable results in both 2006 and 2009 show increases in student performance. This includes 7 out of 33 OECD countries. In three years, Turkey increased its performance by 30 score points, by an average of nearly half a proficiency level (see Box V.E), and Portugal, Korea, Italy, Norway, the United States and Poland by between 10 and 19 score points. Among partner countries, Qatar increased its performance by 30 score points, and Tunisia, Brazil and Colombia by 14 or 15 score points (see Box V.G on Brazil).

In five countries, science performance in 2009 was significantly lower than in 2006. In the Czech Republic student scores decreased by 12 score points, and in Finland and Slovenia they dropped by 9 and 7 score points, respectively. Among partner countries and economies, student scores decreased by 12 score points in Chinese Taipei and by 11 score points in Montenegro.

Performance in science remained unchanged between 2006 and 2009 in 40 countries, when considering a 95% confidence level in PISA. For those countries for which the changes are not statistically significant, Figure V.3.5 provides the p-value which allows the reader to interpret the score point differences.

■ Figure V.3.5 ■

Change in science performance between 2006 and 2009



Note: Statistically significant score point changes are marked in a darker tone.
Countries are ranked in descending order of the score point change in science performance between 2006 and 2009.
Source: OECD, *PISA 2009 Database*, Table V.3.4

StatLink http://dx.doi.org/10.1787/888932359986

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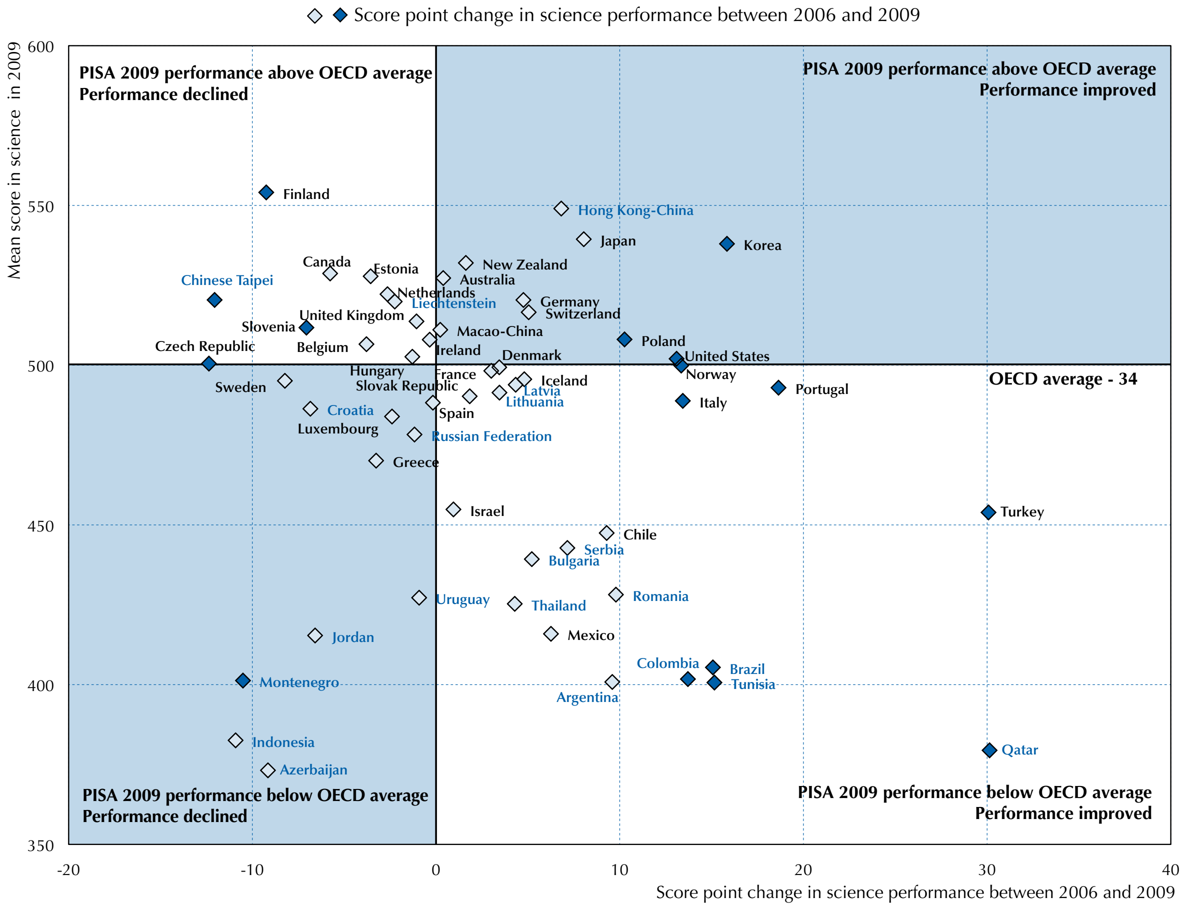
The relative standing of countries according to their mean performance in science is shown in Figure V.3.6 together with the observed changes in science performance. Countries towards the right side of the figure show improvements in science performance since 2006, while those towards the left show a decrease in student scores. Countries towards the top of the figure performed above the OECD average in science in 2009, while those at the bottom performed below the OECD average. This figure can be interpreted in the same way as Figures V.2.2 and V.3.2 (see Chapter 2).

This figure shows that countries with improvements or a decline in science performance tend to be more widely spread across mean performance levels than in mathematics or reading. Countries with improved science performance include Korea, which had performed well above the OECD average in 2006, Poland, which had performed around the OECD average, and Qatar, one of the lowest-performing countries in 2006 (see Boxes V.B on Korea and V.C on Poland). PISA science scores in 2009 were lower than in 2006 for Finland, a top-performing country, and Montenegro, a below-average performer. Although science performance declined in Finland, it still ranks second on the PISA science assessment. Chinese Taipei also performed very well in 2006. While student performance declined, Chinese Taipei still outperforms most of the PISA participants.

Four countries that performed below the OECD average in the PISA 2006 science assessment performed above or close to the average in 2009 because of improvements in learning outcomes. The United States and Norway both saw a performance increase of 13 score points and now they perform at the OECD average. Portugal and Italy saw performance increases of 19 and 13 score points, respectively, and now perform at slightly below the OECD average (see Box V.D on policies implemented in Portugal).

■ Figure V.3.6 ■

How countries perform in science and how science performance has changed since 2006



Note: Score point changes in science performance between 2003 and 2009 that are statistically significant are marked in darker tone.
Source: OECD, *PISA 2009 Database*, Table V.3.4

StatLink http://dx.doi.org/10.1787/888932359986

Slovenia and the Czech Republic performed above the average in 2006, but declined in performance in 2009. Although the performance in Slovenia decreased by 7 score points, Slovenia remains above the OECD average; but a decline of 12 score points in the Czech Republic leaves that country at the OECD average.

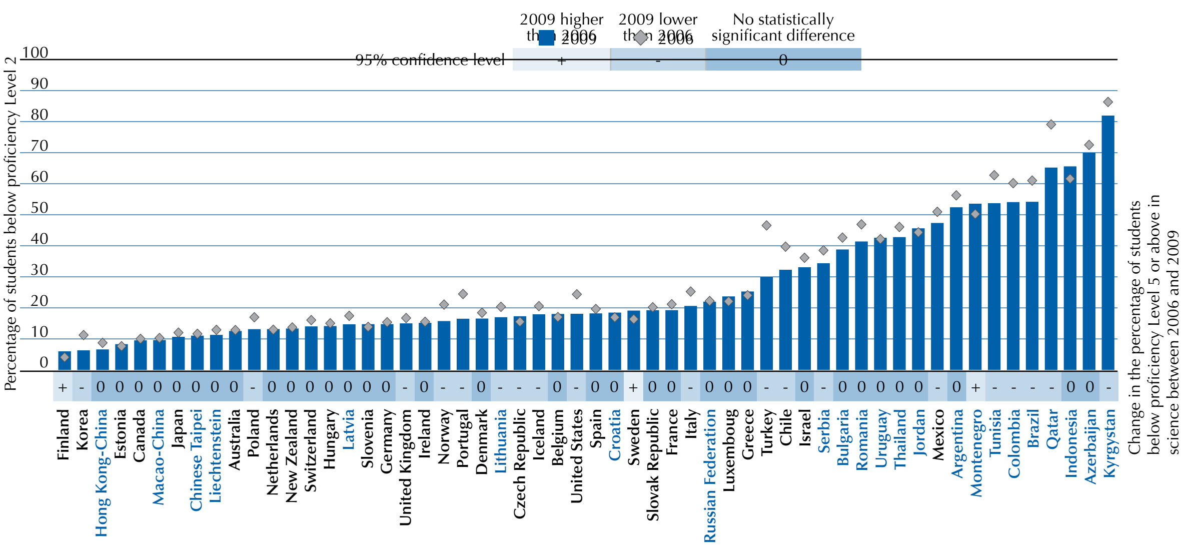
Five low-performing countries are among those that improved their science performance. Among these, Turkey now performs at 454 score points, 30 score points higher than in 2006. Other countries in this group continue to perform at much lower levels – close to 400 score points or below. Qatar increased its performance by 30 score points, but still scores below 400, while Brazil, Colombia and Tunisia increased their performance by around 15 score points and they all now score just above 400 score points. Among low-performing countries, Montenegro declined further in science performance by 11 score points. Other low-performing countries remain at 2006 levels.

In a number of countries, the share of the lowest performers decreased between 2006 and 2009 (Table V.3.5). Among countries that had the largest shares of students who did not reach the baseline Level 2, this share decreased in Qatar by 14 percentage points, even if almost two-thirds of students in Qatar still perform below Level 2. Kyrgyzstan saw a decrease of four percentage points, but the country still has the highest share of lowest performers in 2009. In Tunisia, Brazil and Colombia, the share decreased between 6 and 9 percentage points, although the share of students performing below Level 2 remains around 54% in these countries. Similarly, in Mexico the percentage of students below Level 2 decreased by 4 percentage points, but that proportion remains at a relatively high level of 47%, the highest among OECD countries.

In Turkey the proportion of students performing below Level 2 decreased by 17 percentage points, from 47% to 30%. This is the largest reduction among all countries. Chile saw a reduction in the percentage of lowest performers by 7 percentage points and now 32% of students in Chile perform below proficiency Level 2 in science (see Box V.F on Chile). Italy now shows 21% of students below Level 2, a 5 percentage point decrease since 2006. In the United States and Iceland, 18% of students now perform below Level 2, a decrease of 6 percentage points in the United States and 3 percentage points in Iceland. In the partner country Serbia, this percentage decreased by 4 percentage points to 34% (Figure V.3.7).

■ Figure V.3.7 ■

Percentage of students performing below proficiency Level 2 in science in 2006 and 2009



Countries are ranked in ascending order of the percentage of students below proficiency Level 2 in science in 2009.
Source: OECD, PISA 2009 Database, Table V.3.5
StatLink http://dx.doi.org/10.1787/888932359986

Among countries that had above-average proportions of students who performed below Level 2 in science, but now have below-average proportions of those students, Portugal reduced the share of those students by 8 percentage points to 17% and Norway reduced that share by 5 percentage points to 16%. The partner country Lithuania reduced this share of students by 3 percentage points to 17%.

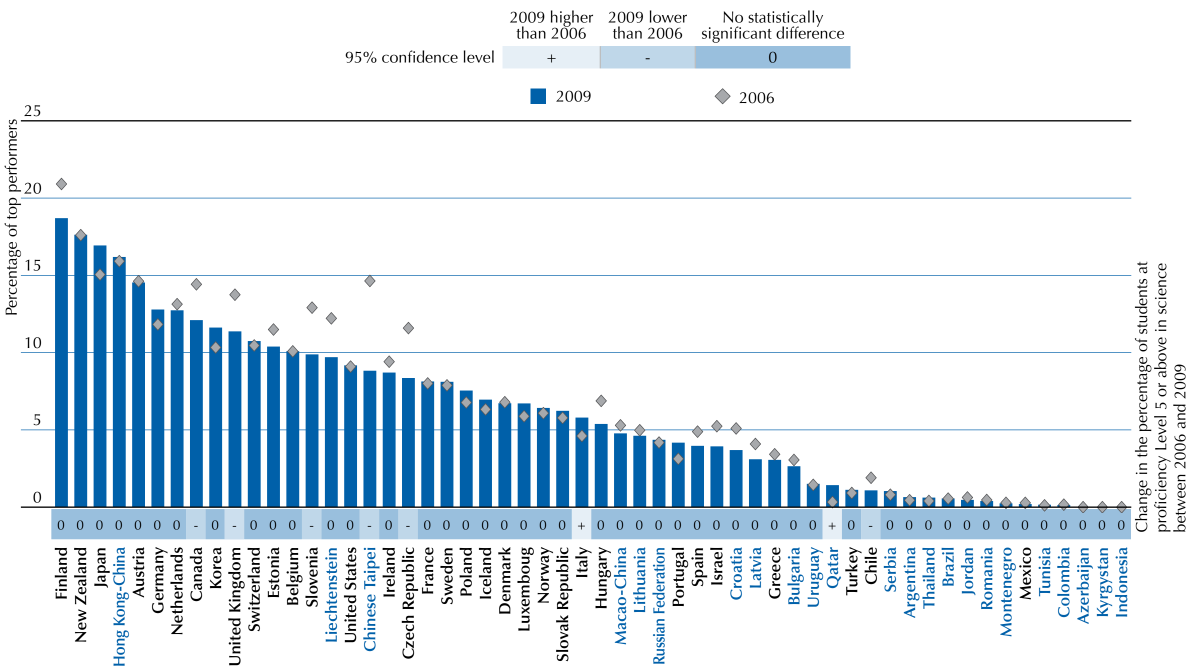
Among countries that had below-average proportions of students who performed below Level 2 in science, only Poland and Korea reduced the proportion further, by 4 and 5 percentage points, respectively. Poland reduced the percentage of lowest performers from 17% to 13%, while Korea reduced it from 11% to 6%, very close to the lowest level among OECD countries.

The share of students performing below Level 2 increased in Sweden from 16% to 19%. In Finland, the percentage of students who perform below Level 2 rose from 4% to 6%, but this remains the lowest proportion across all countries taking part in 2009, as was the case in 2006. The share of students performing below Level 2 increased by 3 percentage points in the partner country Montenegro, where this share was about 50% in 2006.

The percentage of top performers in science increased in only two countries (Table V.3.5). In Italy, the percentage of students at proficiency Level 5 or 6 increased from 5% to 6%, while the partner country Qatar had barely any students at this level in 2006 and now has slightly more than 1%.

The percentage of students performing at Level 5 and above in science decreased only in countries that had above-average percentages of these students in 2006. In the Czech Republic and Slovenia, this share decreased by 3 percentage points, while in the United Kingdom and Canada, the proportion decreased by 2 percentage points. Some 8% of students in the Czech Republic now perform at Level 5 and above, close to the OECD average of 9%. In other countries, the percentage of top performers remained above average in Slovenia (around 10%), the United Kingdom (11%) and Canada (12%). Chile saw a slight reduction from an already low level, from 2% to 1%. The partner economy Chinese Taipei showed the largest reduction in the percentage of top performers in science: 6 percentage points, from 15% to 9%.

■ Figure V.3.8 ■
Percentage of top performers in science in 2006 and 2009



Countries are ranked in descending order of top performers in science in 2009.
Source: OECD, *PISA 2009 Database*, Table V.3.5
StatLink http://dx.doi.org/10.1787/888932359986

Box V.D **Portugal**

In 2000, the PISA reading performance in Portugal was one of the lowest among OECD countries and the proportion of students performing below baseline Level 2 was one of the highest. These results were widely debated in public, leading to a common view that too many Portuguese students lacked the knowledge and skills that were needed in a modern society and economy. In addition, high repetition rates were considered an obstacle to success among students from disadvantaged backgrounds.

The results from the PISA 2003 and 2006 assessments were discussed even more broadly in the context of proposed education reforms. The Minister of Education stressed the importance of the results and the lessons that could be learned from PISA's innovative approach to assessing the creative use of knowledge and skills. Since 2005, Portugal has put in place a vast set of policies designed to improve learning outcomes.

Many of these policies concentrated on reaching and improving the lives of people from disadvantaged backgrounds. Portugal has relatively large inequalities of wealth and one of the lowest shares of higher education among its working population. It is estimated that hourly productivity would be 14.4% higher if the working-age population in Portugal had the same level of education as that in the United States (OECD, 2010c). The reforms aimed to change this situation by improving learning opportunities for children and adults from relatively disadvantage backgrounds.

The Portuguese school system was highly selective with a large number of students repeating grades, many of whom eventually dropped out of school. Continual grade repetition was, and still is, to some extent, considered a trait of the Portuguese school system, and there is a high correlation between poor performance and low socio-economic status.

The concept underlying the policies implemented since 2005 is that improvements in the efficacy and quality of the education system depend on improving equity. The results from PISA have clearly indicated that equity does not have to be forsaken to quality.

Even though the Portuguese school system is almost entirely public, and compulsory education is free until 12th grade or when a student reaches the age of 18, the government has devoted more resources to supporting students from low-income families. Spending on laptops, meals, books, broadband Internet access, English teaching and other extra-curricular activities was subsidised by the government; depending on the family's economic status, additional support was provided to disadvantaged students. These measures were applied from the first year of primary school until the end of secondary school. Between 2005 and 2009, the number of beneficiaries of the School Social Action programme tripled.

Between 2004 and 2009 there was a dramatic decline in the repetition rate in 9th grade, from 21.5% to 12.8%. This, in itself, is a positive sign, given PISA's findings that grade repetition is generally associated with lower performance and a larger impact of socio-economic background on learning outcomes (see Chapter 2 in Volume IV, *What Makes a School Successful?*).This reduction also implied a higher enrolment of students in secondary education (10th to 12th grade) and a consequent decline in the number of students dropping out of school altogether. From 2007 on, the Ministry of Education considered 12th grade to be the minimum educational requirement for all Portuguese citizens. Legislation that extended compulsory education was approved and published in 2009.

In parallel, teachers were provided training, mostly in Portuguese language, mathematics and information technologies. In addition, a new system of evaluating teachers and schools was put in place to increase accountability. Although the original implementation plan was postponed because of opposition to the notion of strengthening accountability measures based on an assessment system, a shift towards more outcome-oriented accountability has already changed the ways teachers and schools perceive external assessments, including PISA. The efficiency of the school system was improved by reducing teacher absenteeism and replacing absent teachers, which helped avoid losing classroom hours.

Current policy also aims to change the management of schools. In 2006 and 2009, Portugal had one of the lowest mean values on the *index of school responsibility in resource allocation* and on the *index of school*

responsibility for curriculum and assessment among OECD countries (see Volume IV, *What Makes a School Successful?* and Tables IV.3.5 and IV.3.6). The policies that are now being implemented give greater autonomy to directors of "school clusters". A school cluster is an organisational unit comprising several schools from kindergarten to 9th or 12th grade, vertically structured under a unique educational project that is led by a director. The director is elected by a council of teachers, parents, students, municipal leaders, institution representatives, and relevant community members. The vast majority of school clusters are now led by an elected director who has much more autonomy to pursue a proposed educational project. This policy is also accompanied by major investments in the physical infrastructure that started in 2008.

As part of the reform, all students in 4th, 6th and 9th grades take part in annual national assessments in Portuguese language and mathematics. Although 4th and 6th grade assessments do not have a direct impact on students progressing through the grade system, these assessments are now applied universally in all schools and provide important evaluations for students, parents and teachers. In addition, secondary schools now offer vocational alternatives to students, and about half of students enrolled in 10th, 11th and 12th grades attend vocational courses. As a result, the number of students enrolled in basic and secondary schools has grown since 2005, ending the worrying decline in enrolment that had been observed since 1995.

Traditionally, mathematics was considered to be the most difficult subject for students in Portugal. In fact, 2003 PISA results in mathematics were even lower than in reading and almost one-third of students performed below Level 2 (see Figure V.3.3 and Table V.3.2). Following the PISA results and the 2005 results on mathematics examinations in 9th grade, the Ministry of Education promoted a broad debate on the subject. The Action Plan for Mathematics, which was launched in 2005 and involves some 78 000 teachers and 400 000 students, has six components: *i)* a mathematics plan in each school; *ii)* training for teachers in basic and secondary schools; *iii)* reinforcing mathematics in initial teacher training; *iv)* readjusting the mathematics curriculum throughout the compulsory education system; *v)* creating a resource bank specifically devoted to mathematics; and *(vi)* evaluating textbooks on mathematics. At the same time, more mathematics teachers were trained and hired.

The National Plan for Reading was launched in 2006 as a joint initiative involving the Ministry of Education, the Ministry of Culture and the Ministry of Parliament. This plan was devoted to improving reading proficiency among children and fostering good reading habits. More than one million children in all school clusters and secondary schools are involved in the programme.

The PISA 2009 results demonstrate that Portugal is making progress in achieving the goals set by the reformers. Among countries that are at or above the OECD average, Portugal was the only one that improved in all three PISA assessment areas, with most improvements occurring between 2006 and 2009 (see Figure V.1.2 and Tables V.2.1, V.3.1, V.3.3 and V.3.4). Reading performance has improved by 19 points since 2000; and over the same nine-year period, the changes for mathematics and science were of similar magnitude, although they were achieved over a shorter period of time.

In reading and science, these positive trends are mostly due to an improvement among the lowest-achieving students. In reading, Portugal reduced the share of low-performing students (below proficiency Level 2) by almost nine percentage points, while the share of top-performers (Level 5 or above) remained at a similar level (see Figures V.2.4 and V.2.5, and Table V.2.2). Similar results can be found in science (see Figures V.3.7 and V.3.8, and Table V.3.5). In mathematics, however, not only did the percentage of low-performers fall by six percentage points, but the share of top-performers also increased by around four percentage points (see Figures V.3.3 and V.3.4, and Table V.3.2).

Portugal is one of the six countries in PISA 2009 that both improved their overall reading performance and lowered variation in performance. This was mainly due to improvements among low achievers while high achievers remained at similar levels.

Box V.E **Turkey**

Turkey joined PISA in 2003. Results from that assessment showed that, with mean mathematics performance at around 425 score points and more than half of the students performing below baseline Level 2, Turkey's 15-year-olds were performing far below the OECD average. The picture was similar in 2006, although by that time, major reforms were already under way.

Turkey improved its mathematics performance by more than 20 score points between 2003 and 2009 (see Figure V.3.1 and Table V.3.1). That increase was accompanied by a 10-percentage-point reduction, from 52% to 42%, in the percentage of students performing below baseline Level 2. In science, Turkey's performance improved by 30 score points since 2006, the equivalent of almost a full school year, with the share of students below Level 2 declining by 17 percentage points from 47% to 30%. This is the largest reduction among the 56 countries with comparable results in the 2006 and 2009 PISA assessments.

Among several programmes that were implemented in Turkey, the Basic Education Programme (BEP) that started in 1998 had an impact on almost all students (OECD, 2007). The objectives of this programme, based on international educational standards, included expanding primary school education, improving the quality of education and overall student outcomes, closing the performance gap between boys and girls, providing equal opportunities, matching the performance indicators of the European Union, developing school libraries, increasing the efficiency of the education system, ensuring that qualified personnel were employed, integrating information and communication technologies into the education system and creating local learning centres, based in schools, that are open to everyone.

One of the major changes introduced with the BEP programme involved the compulsory education law. This change was first implemented in the 1997/1998 school year, and in 2003 the first students graduated from the eight-year compulsory education system. Since the launch of this programme, the attendance rate among students within the eight-year primary education system increased from around 85% to nearly 100%, while the attendance rate in pre-primary programmes increased from 10% to 25%. In addition, the system was expanded to include 3.5 million more pupils, average class size was reduced to roughly 30, all students learned at least one foreign language, computer laboratories were established in every primary school and overall conditions were improved in all 35 000 rural schools. Resources devoted to the programme exceeded the equivalent of USD 11 billion. This programme did not directly affect school participation for most of the 15-year-olds assessed by PISA, who are mainly in secondary schools where enrolment rates are close to 60%.

In line with those goals, and given Turkey's experiences with international assessments like PISA, new curricula were implemented in the 2006-2007 school year, starting from the 6th grade. The secondary school mathematics and language curricula were also revised and a new science curriculum was applied in the 9th grade for the 2008/2009 school year. PISA 2009 students had already been taught for one year using the new curriculum, although they still received their primary school education in the former system. The standards of the new curricula were intended to meet PISA goals: *"Increased importance has been placed on students' doing mathematics which means exploring mathematical ideas, solving problems, making connections among mathematical ideas, and applying them in real life situations (Talim ve Terbiye Kurulu [TTKB] [Board of Education], 2008)*.

The curricular reform was designed not only to change the content of school education and encourage the introduction of innovative teaching methods, but above all to change the teaching philosophy and culture within schools. The new curricula and teaching materials emphasise "student-centred learning", giving students a more active role than before, when memorising information had been the dominant approach. They also reflect the assumption, on which PISA is based, that schools should equip students with the necessary skills and competencies that would ensure their success at school and in life, in general.

Several policies had sought to change the culture and management of schools. Schools were obliged to propose a plan of work, including development targets and strategic plans for reaching them. More democratic governance, parental involvement and teamwork were suggested. In 2004, a project aimed at teaching students democratic skills was started in all primary and secondary schools, with many responsibilities assigned to

student assemblies. This was accompanied by the development of new inspection tools that were more transparent and performance-oriented.

Private investments were also used to increase the capacity of the school system in Turkey. Throughout 2004 and 2005, private-sector investments funded 14 000 additional classrooms. Taxes were reduced for private businesses that invested in education. This was particularly helpful in provinces where there was large internal migration (OECD, 2006c).

Such major changes were accompanied by policies aimed directly at teachers. New arrangements were implemented to train teachers for upper-secondary education through five-year graduate studies. The arrangements also stipulated that graduates in other fields, such as science or literature, who wanted to teach would also have to attend a year-and-a-half of graduate training in education.

Several projects implemented in Turkey over the past decade have addressed equity issues. The Girls to Schools Now campaign that started in 2003 aimed to ensure that 100% of girls attended primary school (ages 6-14). Since 2003, textbooks for all primary-school students have been supplied free of charge by the Ministry of National Education. More recently, a Complementary Training Programme, begun in 2008, tries to ensure that 10 to 14-year-olds acquire a basic education even if they have never been enrolled in a school or if they had dropped out of school.

Whatever the relationship between these initiatives and the learning outcomes observed, with one of the largest improvements in both mathematics and science performance, Turkey is on its way to reaching the educational standards of other OECD countries.

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