INDICATOR A5

BETWEEN- AND WITHIN-SCHOOL VARIATION IN THE MATHEMATICS PERFORMANCE OF 15-YEAR-OLDS

This indicator examines the between- and within-school variation in student performance on the mathematics scale. It also compares between-school variation in PISA 2000 and PISA 2003.

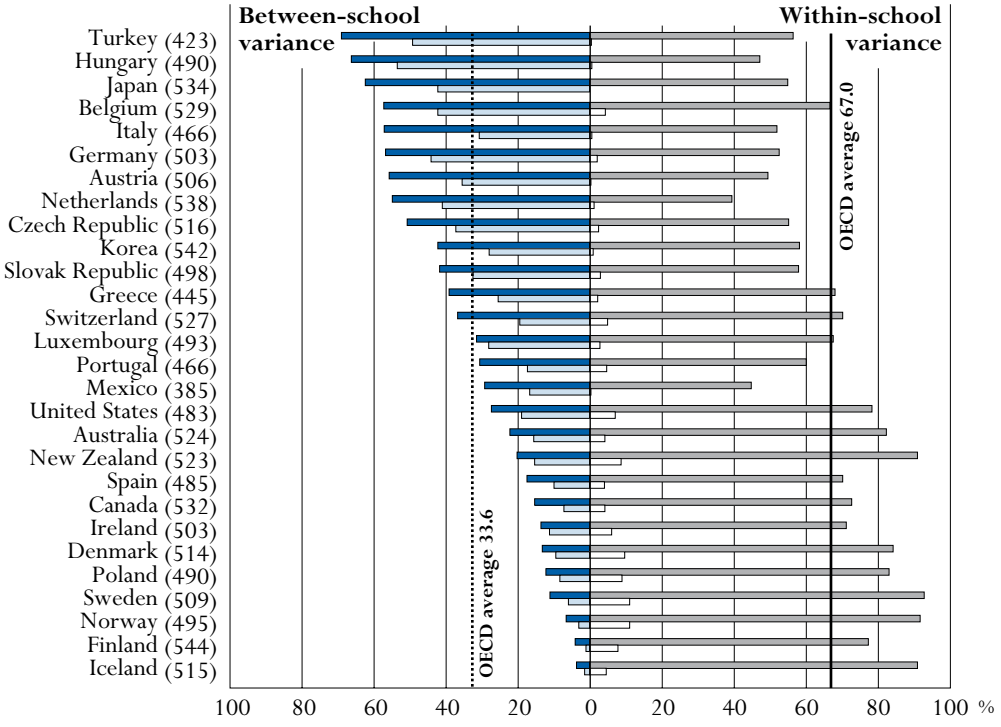
Key results

Chart A5.1. Variance in student performance between and within schools on the OECD PISA mathematics scale (2003)

The chart shows to what extent mathematics performance varies between schools. The longer the left side of the bar, the greater the performance differences among schools. This is measured by the percentage of the average variance in performance that lies between schools. One hundred points on this index equals the total variation in student performance, between and within schools, on average in OECD countries.

- Total between-school variance
- Between-school variance explained by the index of economic, social and cultural status of students and schools
- Total within-school variance
- Within-school variance explained by the index of economic, social and cultural status of students and schools

The proportion of between-school variance is around one-tenth of the OECD average level in Finland and Iceland, and half or less in Canada, Denmark, Ireland, Norway, Poland and Sweden. In these countries, performance is largely unrelated to the schools in which students are enrolled. Canada, Denmark, Finland, Iceland, Ireland, Norway and Sweden also perform well or at least above the OECD average level. Parents in these countries can be less concerned about school choice in order to enhance their children's performance, and can be confident of high and consistent performance standards across schools in the entire education system.



Source: OECD PISA 2003 database. Table A5.1.

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Other highlights of this indicator

- Students in all OECD countries show widely varying performance, but countries vary widely in the extent to which students in different schools perform differently. On average across OECD countries, differences in the performance in mathematics between schools account for 34% of total variation in achievement. However, in nine countries between-school variation is above half the overall variation in OECD countries, while in three countries it is below 10%.

- While some between-school variance is attributable to students' socio-economic backgrounds, some of it also likely reflects the structural features of schools and/or education systems, and/or the policies and practices of school administrators and teachers. Thus, there may be an added value associated with attending a particular school.

- Some, though not all, countries that performed well in PISA also showed low or modest levels of between-school variance, suggesting that securing similar student performance among schools is a policy goal that is both important in itself and compatible with the goal of high overall performance standards.

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Policy context

Catering for the needs of a diverse student body and narrowing the gaps in student performance represent formidable challenges for all countries. The approaches that countries have chosen to address these demands vary. Some countries have comprehensive school systems with no, or only limited, institutional differentiation. They seek to provide all students with similar opportunities for learning by requiring each school and teacher to provide for the full range of student abilities, interests and backgrounds. Other countries respond to diversity by grouping students through tracking or streaming, whether between schools or between classes within schools, with the aim of serving students according to their academic potential and/or interests in specific programs. In many countries, combinations of the two approaches occur. Even in comprehensive school systems, there may be variation in performance levels between schools, due to the socio-economic and cultural characteristics of the communities that are served, or due to geographical differences (such as between regions, provinces or states in federal systems, or between rural and urban areas). Finally, there may be differences between individual schools, such as the type or quality of instruction. As a result, even in comprehensive systems, the performance levels attained by students may still vary across schools. This indicator examines the between- and within-school variation in students' performance on the mathematics scale.

Evidence and explanations

Chart A5.1 above shows considerable differences in the extent to which mathematics competencies of 15-year-old students vary within each country (Table 5.1). The total length of the bars indicates the observed variance in student performance on the PISA mathematics scale. The values in Chart A5.1 are expressed as percentages of the average variance between OECD countries in student performance on the PISA mathematics scale.

The average is calculated over the OECD countries included in the table. A value larger than 100 indicates that variance in student performance is greater in the corresponding country than on average among OECD countries. Similarly, a value smaller than 100 indicates below-average variance in student performance. For example, the variance in student performance in Finland, Ireland and Mexico is more than 15% below the OECD average variance. By contrast, in Belgium, Japan and Turkey, variance in student performance is at least 15% above the OECD average level. The OECD average level is calculated simply as the arithmetic mean of the respective country values. This average differs from the square of the OECD average standard deviation shown in Chapter 2 of *Learning for Tomorrow's World – First Results from PISA 2003* (OECD, 2004a), since the latter includes the performance variation among countries whereas the former simply averages the within-country performance variation across countries.

In Chart A5.1, a distinction is made for each country between the variation attributable to differences in student results attained by students in different schools (between-school differences) and that attributable to the range of student results within schools (within-school differences). Note that, because of the manner in which students were sampled, the within-school variation includes variation between classes as well as between students. The length of the bars to the left

of the central line shows between-school differences, and also serves to order countries in the figure. The length of the bars to the right of the central line shows the within-school differences. Therefore, longer segments to the left of the central line indicate greater variation in the mean performance of different schools while longer segments to the right of the central line indicate greater variation among students within schools.

As presented in Chart A5.1, while all countries show considerable within-school variance, in most countries variance in student performance between schools is also considerable. On average across OECD countries, differences in the performance of 15-year-olds between schools account for 34% of the total variation in student performance in OECD countries. See Box A5.1 for an indication of how between-school variation in PISA 2003 compares to PISA 2000.

In Hungary and Turkey, variation in performance between schools is particularly large and is about twice the OECD average between-school variance. In Austria, Belgium, the Czech Republic, Germany, Italy, Japan and the Netherlands, the proportion of between-school variance is still over one-and-a-half times that of the OECD average level (third column, Table A5.1). Where there is substantial variation in performance between schools and less variation between students within schools, students tend to be grouped in schools in which other students perform at levels similar to their own. This may reflect school choices made by families or residential location, as well as policies on school enrolment or the allocation of students to different curricula. To capture variation between education systems and regions within countries, some countries have undertaken the PISA assessment at regional levels.

The proportion of between-school variance is around one-tenth of the OECD average level in Finland and Iceland, and half or less in Canada, Denmark, Ireland, Norway, Poland and Sweden. In these countries, performance is largely unrelated to the schools in which students are enrolled (see Table 5.1). This suggests that the learning environment is similar in the ways that it affects the performance of students. It is noteworthy that Canada, Denmark, Finland, Iceland, Ireland, Norway and Sweden also perform close to or above the OECD average level. Parents in these countries can be less concerned about school choice in order to enhance their children's performance, and can be confident of high and consistent performance standards across schools in the entire education system.

While some of the variance between schools is attributable to the socio-economic background of students entering the school, some of it is also likely to reflect certain structural features of schools and education systems, particularly in systems where students are tracked by ability. Some of the variance in performance between schools also may be attributable to the policies and practices of school administrators and teachers. In other words, there is an added value associated with attending a particular school.

It is important to note that some, though not all, high-performing countries also show low or modest levels of between-school variance. This suggests that securing similar student performance among schools, perhaps most importantly by identifying and reforming poorly performing schools, is a policy goal that is both important in itself and compatible with the goal of high overall performance standards.

Box A5.1. Comparing between-school variation in PISA 2000 and PISA 2003

For most countries, the 2003 results are similar to those observed in the PISA 2000 assessment. However, there are some exceptions. For instance, in Poland, the move towards a more integrated education system since 1999 – as a consequence of which institutional differentiation now occurs mainly after the age of 15 – may have contributed to the observed dramatic reduction in the between-school variation in mathematics performance of 15-year-old students. Between-school variance in Poland fell from more than half of the overall performance variation in Poland in 2000 (see *Learning for Tomorrow's World – First Results from PISA 2003* [OECD, 2004a], Table 4.1b) to just 13% in 2003 (see the same publication, Table 4.1a). Note that in all countries, the changes between 2000 and 2003 are very similar for the two mathematics subscales for which trend data can be estimated. For the purpose of this comparison, results are only shown for the overall mathematics scale, even though the PISA 2000 data did not include two of the four mathematical content areas used in PISA 2003. Simultaneously, the average performance of 15-year-olds in Poland is significantly higher in both mathematical content areas, and the overall performance gap between the lower and higher achievers is narrower than it was in 2000. The increase in average mathematics performance is thus mainly attributable to an increase in performance at the lower end of the performance distribution (*i.e.* the 5th, 10th and 25th percentiles). This has occurred to such an extent that in 2003 fewer than 5% of students fell below the performance standards that 10% of Polish students had failed to attain in 2000 (for data, see *www.pisa.oecd.org*).

Performance differences among schools were also lower in some other countries in 2003: for example, in Belgium, Greece and Mexico, the proportion of national variation in student performance attributable to between-school variance is between 8 to 10 percentage points lower than in 2000. Note that in Belgium some of this difference may likely be attributable to changes in the ways in which schools were defined for the purposes of sampling in PISA. In contrast, in Italy, the proportion of variance that lies between schools increased by more than 10 percentage points.

Definitions and methodology

The achievement scores are based on assessments administered in 2003 as part of the Programme for International Student Assessment (PISA) undertaken by the OECD.

The target population studied for this indicator was 15-year-old students. Operationally, this referred to students who were from 15 years and 3 (completed) months to 16 years and 2 (completed) months at the beginning of the testing period and who were enrolled in an educational institution, irrespective of the grade levels or type of institutions in which they were enrolled, and irrespective of whether they participated in school full-time or part-time.

Variation in this indicator is expressed by statistical variance. This is obtained by squaring the standard deviation. The statistical variance rather than the standard deviation is used for this comparison to allow for the decomposition of the components of variation in student performance. For reasons explained in the *PISA 2003 Technical Report* (OECD, 2005c), and most importantly because the data in this table only account for students with valid data on their socio-economic background, the variance may differ from the square of the standard deviation.

The between-school variation is influenced by the ways in which schools are defined and organised within countries and by the units that were chosen for sampling purposes. For example, in some countries some of the schools in the PISA sample were defined as administrative units (even if they spanned several geographically separate institutions, as in Italy; in others they were defined as those parts of larger educational institutions that serve 15-year-olds; in others they were defined as physical school buildings; and in yet others they were defined from a management perspective (*e.g.* entities having a principal). The *PISA 2003 Technical Report* (OECD, 2005c) provides an overview of how schools were defined.

Further references

For further information about PISA 2003, see *Learning for Tomorrow's World – First Results from PISA 2003* (OECD, 2004a), *Problem Solving for Tomorrow's World – First Measures of Cross-Curricular Competencies from PISA 2003* (OECD, 2004b) and the *PISA 2003 Technical Report* (OECD, 2005c). PISA data is also available on the PISA Web site: *www.pisa.oecd.org.*

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Table A5.1.

Between-school and within-school variance in student performance on the OECD PISA mathematics scale (2003)

		Variance expressed as a percentage of the average variance in student performance (SP) across OECD countries[1]											
	Total variance in SP[2]	Total variance in SP expressed as a percentage of the average variance in student performance across OECD countries[3]	Total variance in SP between schools[4]	Total variance in SP within schools	Variance explained by the international index of economic, social and cultural status of students		Variance explained by the international index of economic, social and cultural status of students and schools		Variance explained by students' study programmes		Variance explained by students' study programmes and the international index of economic, social and cultural status of students and schools		Total variance between schools expressed as a percentage of the total variance within the country[5]
					Between-school variance explained	Within-school variance explained	Between-school variance explained	Within-school variance explained	Between-school variance explained	Within-school variance explained	Between-school variance explained	Within-school variance explained	
OECD countries													
Australia	9 036	105.1	22.1	82.3	9.0	4.2	15.4	4.3	1.8	2.8	16.7	6.8	21.1
Austria	8 455	98.4	55.5	49.5	7.6	0.6	35.2	0.5	42.6	0.4	45.3	0.9	52.9
Belgium	10 463	121.8	56.9	66.7	17.7	4.4	42.0	4.4	49.1	15.8	52.1	17.0	46.0
Canada	7 626	88.7	15.1	72.6	4.7	4.2	7.1	4.3	2.6	5.0	7.0	8.5	17.3
Czech Republic	8 582	99.9	50.5	55.2	13.8	2.5	37.0	2.6	34.1	0.2	41.6	2.7	47.8
Denmark	8 289	96.5	13.1	84.2	7.7	9.7	9.3	9.8	1.6	0.1	9.7	9.9	13.4
Finland	6 974	81.2	3.9	77.3	0.9	7.9	0.9	7.9	0.0	0.0	0.9	7.9	4.8
France	w	w	w	w	w	w	w	w	w	w	w	w	w
Germany	9 306	108.3	56.4	52.6	14.1	2.2	43.8	2.2	47.2	1.1	50.7	3.2	51.7
Greece	8 752	101.8	38.9	68.1	10.3	2.5	25.2	2.3	28.3	-0.0	32.9	2.3	36.3
Hungary	8 726	101.5	66.0	47.3	15.6	1.0	53.2	0.7	49.0	-0.1	57.1	0.8	58.3
Iceland	8 123	94.5	3.6	90.9	1.3	4.7	1.3	4.7	0.0	0.0	1.3	4.7	3.8
Ireland	7 213	83.9	13.4	71.2	7.8	6.0	11.1	6.1	1.4	4.4	11.0	10.0	15.9
Italy	9 153	106.5	56.8	52.0	6.6	0.7	30.5	0.7	26.0	0.1	34.6	0.7	52.2
Japan	9 994	116.3	62.1	55.0	3.3	0.1	42.0	0.1	5.2	-0.0	42.9	0.1	53.1
Korea	8 531	99.3	42.0	58.2	7.7	1.1	27.8	1.1	21.5	0.6	31.2	1.6	42.0
Luxembourg	8 432	98.1	31.2	67.6	9.3	3.0	27.9	2.9	14.8	14.6	27.8	15.7	31.6
Mexico	7 295	84.9	29.1	44.8	4.2	0.3	16.6	0.4	12.7	0.0	20.8	0.5	39.4
Netherlands	7 897	91.9	54.5	39.5	8.8	1.3	40.7	1.3	50.8	7.8	51.4	8.4	58.0
New Zealand	9 457	110.1	20.1	90.9	9.8	8.7	15.2	8.8	0.8	3.1	15.2	11.4	18.1
Norway	8 432	98.1	6.5	91.7	2.7	11.1	2.9	11.2	0.2	0.1	2.9	11.2	6.6
Poland	8 138	94.7	12.0	83.1	7.1	8.9	8.2	9.0	0.8	0.1	8.3	9.0	12.6
Portugal	7 647	89.0	30.3	60.0	9.5	4.8	17.2	4.8	26.5	8.6	28.6	11.6	33.6
Slovak Republic	8 478	98.7	41.5	58.0	12.9	3.1	32.3	3.1	26.0	0.4	33.6	3.4	41.7
Spain	7 803	90.8	17.2	70.2	6.4	4.1	9.8	4.2	0.0	0.0	9.8	4.2	19.7
Sweden	8 880	103.3	10.9	92.8	4.7	11.2	5.8	11.2	1.5	0.6	6.9	11.6	10.5
Switzerland	9 542	111.0	36.4	70.2	9.4	5.1	19.3	5.1	6.1	1.0	19.8	6.0	34.2
Turkey	10 952	127.4	68.7	56.5	10.1	0.7	49.0	0.6	42.5	3.1	56.0	3.4	54.9
United States	9 016	104.9	27.1	78.3	12.1	7.0	18.7	7.2	3.2	2.8	19.2	9.2	25.7
OECD average	***8 593***	***100.0***	***33.6***	***67.0***	***8.5***	***4.4***	***23.0***	***4.4***	***17.8***	***2.6***	***26.4***	***6.5***	

1. The variance components were estimated for all students in participating countries with data on socio-economic background and study programmes. Students in special education programmes were excluded from these analyses.
2. The total variance in student performance is obtained as the square of the standard deviation shown in *Learning for Tomorrow's World* (OECD, 2004a), Chapter 2. The statistical variance in student performance and not the standard deviation is used for this comparison to allow for the decomposition.
3. The sum of the between- and within-school variance components, as an estimate from a sample, does not necessarily add up to the total.
4. In some countries, sub-units within schools were sampled instead of schools and this may affect the estimation of the between-school variance components. In Austria, the Czech Republic, Hungary, Italy and Japan, schools with more than one study programme were split into the units delivering these programmes. In the Netherlands, for schools with both lower and upper secondary programmes, schools were split into units delivering each programme level. In Mexico, schools where instruction is delivered in shifts were split into the corresponding units. In the Flemish part of Belgium, in case of multi-campus schools, implantations (campuses) were sampled whereas in the French part, in case of multi-campus schools the larger administrative units were sampled. In the Slovak Republic, in case of schools with both Slovak and Hungarian as test languages, schools were split into units delivering each language of instruction.
5. This index is often referred to as the intra-class correlation (rho).

Source: OECD PISA 2003 database.

Please refer to the Reader's Guide (www.oecd.org/eag2006) for information concerning the symbols replacing missing data.

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