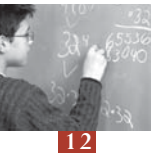
12

# Sampling Outcomes





This chapter reports on PISA sampling outcomes. Details of the sample design are given in Chapter 4.

Table 12.1 shows the various quality indicators for population coverage, and the various pieces of information used to derive them. The following notes explain the meaning of each coverage index and how the data in each column of the table were used.

Indices 1, 2 and 3 are intended to measure PISA population coverage. Indices 4 and 5 are intended to be diagnostic in cases where indices 1, 2 or 3 have unexpected values. Many references are made in this chapter to the various sampling forms on which the National Project Managers (NPMs) documented statistics and other information needed in undertaking the sampling. The forms themselves are included in Appendix 1.

*Index 1:* Coverage of the national desired population, calculated by P/(P+E) ×3[c]/3[a].

- The national desired population (NDP), defined by sampling form 3 response box [a] and denoted here as 3[a] (and in Table 12.1 as "target desired population"), is the population that includes all enrolled 15-year-olds in each country in grades 7 and above (with the possibility of small levels of exclusions), based on national statistics. However, the final NDP reflected on each country's school sampling frame might have had some school-level exclusions. The value that represents the population of enrolled 15-year-olds minus those in excluded schools is represented initially by response box [c] on sampling form 3. It is denoted here as 3[c] (and in Table 12.1 as "target minus school level exclusions"). New in PISA 2003 was the procedure that very small schools having only one or two eligible students could not be excluded from the school frame, but could be excluded in the field if they still had exactly only one or two eligible students at the time of data collection. Therefore, what is noted in index 1 as 3[c] is a number that excludes schools excluded from the sampling frame in addition to those schools excluded in the field. Thus, the term 3[c]/3[a] provides the proportion of the NDP covered in each country based principally on national statistics.
- The value (*P*+*E*) provides the weighted estimate from the student sample of all eligible 15-year-olds in each country, where *P* is the weighted estimate of eligible non-excluded 15-year-olds and *E* is the weighted estimate of eligible 15-year-olds that were excluded within schools. Therefore, the term *P*/(*P*+*E*) provides an estimate based on the student sample of the proportion of the eligible 15-year-old population represented by the non-excluded eligible 15-year-olds.
- Thus, the result of multiplying these two proportions together (3[c]/3[a] and *P*/(*P*+*E*)) indicates the overall proportion of the NDP covered by the non-excluded portion of the student sample.

*Index 2:* Coverage of the national enrolled population, calculated by *P*/(*P*+*E*)×3[c]/2[b].

- The national enrolled population (NEP), defined by sampling form 2 response box [b] and denoted here as 2[b] (and as "enrolled 15-year olds" in Table 12.1), is the population that includes all enrolled 15-year-olds in each country in grade 7 and above, based on national statistics. The final NDP, denoted here as 3[c] as described above for coverage index 1, reflects the 15-year-old population after school-level exclusions. This value represents the population of enrolled 15-year-olds less those in excluded schools.
- The value (*P*+*E*) provides the weighted estimate from the student sample of all eligible 15-year-olds in each country, where *P* is the weighted estimate of eligible non-excluded 15-year-olds and *E* is the weighted estimate of eligible 15-year-olds that were excluded within schools. Therefore, the term *P*/(*P*+*E*) provides an estimate based on the student sample of the proportion of the eligible 15-year-old population that is represented by the non-excluded eligible 15-year-olds.



- Multiplying these two proportions together (3[c]/2[b] and $P/(P+E)$) gives the overall proportion of the NEP that is covered by the non-excluded portion of the student sample.

*Index 3:* Coverage of the national 15-year-old population, calculated by $P/2$[a].

- The national 15-year-old population, defined by sampling form 2 response box [a] and denoted here as 2[a] (called "all 15-year-olds" in Table 12.1), is the entire population of 15-year-olds in each country (enrolled and not enrolled), based on national statistics. The value $P$ is the weighted estimate of eligible non-excluded 15-year-olds from the student sample. Thus, $P/2$[a] indicates the proportion of the national 15-year-old population covered by the eligible, non-excluded portion of the student sample.

*Index 4:* Coverage of the estimated school population, calculated by $(P+E)/S$.

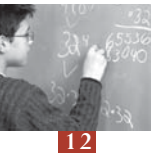
- The value $(P+E)$ provides the weighted estimate from the student sample of all eligible 15-year-olds in each country, where $P$ is the weighted estimate of eligible non-excluded 15-year-olds and $E$ is the weighted estimate of eligible 15-year-olds that were excluded within schools.
- The value $S$ is an estimate of the 15-year-old school population in each country (called "enrolled students on frame" in Table 12.1). This is based on the actual or (more often) approximate number of 15-year-olds enrolled in each school in the sample, prior to contacting the school to conduct the assessment. The S value is calculated as the sum over all sampled schools of the product of each school's sampling weight and its number of 15-year-olds (*ENR*) as recorded on the school sampling frame. In the infrequent case where the *ENR* value was not available, the number of 15-year-olds from the student tracking form was used.
- Thus, $(P+E)/S$ is the proportion of the estimated school 15-year-old population that is represented by the weighted estimate from the student sample of all eligible 15-year-olds. Its purpose is to check whether the student sampling has been carried out correctly, and to assess whether the value of $S$ is a reliable measure of the number of enrolled 15-year-olds. This is important for interpreting Index 5.

*Index 5*: Coverage of the school sampling frame population, calculated by $S/3$[c].

- The value $S/3$[c] is the ratio of the enrolled 15-year-old population, as estimated from data on the school sampling frame, to the size of the enrolled student population, as reported on sampling form 3 and adjusted by removing any additional excluded schools in the field. In some cases, this provides a check as to whether the data on the sampling frame give a reliable estimate of the number of 15-year-olds in each school. In other cases, however, it is evident that 3[c] has been derived using data from the sampling frame by the NPM, so that this ratio may be close to 1.0 even if enrolment data on the school sampling frame are poor. Under such circumstances, Index 4 will differ noticeably from 1.0, and the figure for 3[c] will also be inaccurate.

Tables 12.2, 12.3 and 12.4 present school and student-level response rates. Table 12.2 indicates the rates calculated by using only original schools and no replacement schools. Table 12.3 indicates the improved response rates when first and second replacement schools were accounted for in the rates. Table 12.4 indicates the student response rates among the full set of participating schools.

For calculating school response rates before replacement, the numerator consisted of all original sample schools with enrolled age-eligible students who participated (*i.e.* assessed a sample of eligible students, and obtained a student response rate of at least 50 per cent). The denominator consisted of all the schools in the numerator, plus those original sample schools with enrolled age-eligible students that either did not participate or failed to assess at least 50 per cent of eligible sample students. Schools that were included in the sampling frame, but were found to have no age-eligible students, or which were excluded in the





## Table 12.1 ■ Sampling and coverage rates

| | All 15-year-olds | Enrolled 15-year-olds | Target desired population | School-level exclusions | Target minus school-level exclusions | School-level exclusions (%) | Enrolled students on frame | Participants | | Excluded | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | Actual | Weighted | Actual | Weighted |
| Australia | 268 164 | 250 635 | 248 035 | 1 621.00 | 246 414 | 0.65 | 275 208 | 12 551 | 235 591 | 228 | 3 612 |
| Austria | 94 515 | 89 049 | 89 049 | 320.59 | 88 728 | 0.36 | 87 795 | 4 597 | 85 931 | 60 | 1 099 |
| Belgium | 120 802 | 118 185 | 118 185 | 561.00 | 117 624 | 0.47 | 118 010 | 8 796 | 111 831 | 102 | 1 193 |
| Brazil | 3 618 332 | 2 359 854 | 2 348 405 | 0.00 | 2 348 405 | 0.00 | 2 340 538 | 4 452 | 1 952 253 | 5 | 2 142 |
| Canada[9] | 398 865 | 399 265 | 397 520 | 6 600.11 | 390 920 | 1.66 | 375 622 | 27 953 | 330 436 | 1 993 | 18 328 |
| Czech Republic[11] | 130 679 | 126 348 | 126 348 | 1 294.08 | 125 054 | 1.02 | 123 855 | 6 320 | 121 183 | 22 | 218 |
| Denmark[14] | 59 156 | 58 188 | 58 188 | 628.00 | 57 560 | 1.08 | 56 234 | 4 218 | 51 741 | 214 | 2 321 |
| Finland[12] | 61 107 | 61 107 | 61 107 | 1 324.00 | 59 783 | 2.17 | 59 766 | 5 796 | 57 883 | 79 | 725 |
| France | 809 053 | 808 276 | 774 711 | 18 056.00 | 756 655 | 2.33 | 757 355 | 4 300 | 734 579 | 51 | 8 158 |
| Germany[15] | 951 800 | 916 869 | 916 869 | 5 600.00 | 911 269 | 0.61 | 904 387 | 4 660 | 884 358 | 61 | 11 533 |
| Greece[7, 13] | 111 286 | 108 314 | 108 314 | 808.45 | 107 506 | 0.75 | 102 384 | 4 627 | 105 131 | 144 | 2 652 |
| Hong Kong-China | 75 000 | 72 631 | 72 631 | 601.00 | 72 030 | 0.83 | 72 312 | 4 478 | 72 484 | 8 | 103 |
| Hungary | 129 138 | 123 762 | 123 762 | 0.00 | 6 939 | 0.00 | 118 207 | 4 765 | 107 044 | 62 | 1 065 |
| Iceland | 4 168 | 4 112 | 4 112 | 3 687.54 | 120 074 | 2.98 | 4 086 | 3 350 | 3 928 | 79 | 79 |
| Indonesia[5] | 4 281 895 | 3 113 548 | 2 968 756 | 26.00 | 4 086 | 0.63 | 2 173 824 | 10 761 | 1 971 476 | 0 | 0 |
| Ireland[17] | 61 535 | 58 997 | 58 906 | 9 292.38 | 2 959 464 | 0.31 | 58 499 | 3 880 | 54 850 | 139 | 1 619 |
| Italy[1] | 561 304 | 574 611 | 574 611 | 864.43 | 58 042 | 1.47 | 563 039 | 11 639 | 481 521 | 188 | 6 794 |
| Veneto - NE | 37 843 | 36 388 | 36 388 | 2 868.48 | 571 743 | 0.50 | 35 056 | 1 538 | 30 854 | 22 | 416 |
| Trento - NE | 4 534 | 4 199 | 4 199 | 242.47 | 36 146 | 0.67 | 3 962 | 1 030 | 3 324 | 20 | 73 |
| Toscana - Centro | 27 111 | 29 208 | 29 208 | 76.85 | 4 122 | 1.83 | 28 272 | 1 509 | 25 722 | 21 | 346 |
| Piemonte - NW | 33 340 | 33 242 | 33 242 | 160.77 | 29 047 | 0.55 | 33 552 | 1 565 | 30 107 | 27 | 522 |
| Lombardia - NW | 76269 | 74 994 | 74 994 | 185.19 | 33 057 | 0.56 | 72 657 | 1 545 | 63 916 | 38 | 2 037 |
| Bolzano - NE | 4 908 | 4 087 | 4 087 | 252.11 | 74 742 | 0.34 | 3 967 | 1 264 | 3 464 | 25 | 67 |
| Japan | 1 365 471 | 1 328 498 | 1 328 498 | 9.12 | 4 078 | 0.22 | 1 314 227 | 4 707 | 1 240 054 | 0 | 0 |
| Korea | 606 722 | 606 370 | 606 370 | 2 729.00 | 603 641 | 0.45 | 614 825 | 5 444 | 533 504 | 24 | 2 283 |
| Latvia | 37 544 | 37 138 | 37 138 | 13 592.00 | 1 314 906 | 1.02 | 35 509 | 4 627 | 33 643 | 44 | 380 |
| Liechtenstein | 402 | 348 | 348 | 1 419.00 | 35 719 | 3.82 | 34 800 | 332 | 338 | 5 | 5 |
| Luxembourg[16] | 4 204 | 4 204 | 4 204 | 0.00 | 348 | 0.00 | 4 090 | 3 923 | 4 080 | 66 | 66 |
| Macao-China | 8 318 | 6 939 | 6 939 | 0.00 | 4204 | 0.00 | 6 992 | 1 250 | 6 546 | 4 | 13 |
| Mexico[23] | 2 192 452 | 1 273 163 | 1 273 163 | 46 482.97 | 1 226 680 | 3.65 | 1 204 851 | 29 983 | 1 071 650 | 34 | 7 264 |
| Netherlands[3] | 194 216 | 194 216 | 194 216 | 2 559.00 | 191 657 | 1.32 | 195 725 | 3 992 | 184 943 | 20 | 1 041 |
| New Zealand | 55 440 | 53 293 | 53 160 | 194.00 | 52 966 | 0.36 | 53 135 | 4 511 | 48 638 | 263 | 2 411 |
| Norway | 56 060 | 55 648 | 55 531 | 294.00 | 55 237 | 0.53 | 54 874 | 4 064 | 52 816 | 139 | 1 563 |
| Poland | 589 506 | 569 294 | 569 294 | 14 600.00 | 554 694 | 2.56 | 558 752 | 4 383 | 534 900 | 75 | 7 517 |
| Portugal[8] | 109 149 | 99 216 | 99 216 | 826.42 | 98 390 | 0.83 | 106 916 | 4 608 | 96 857 | 84 | 1 450 |
| Russian Federation[10] | 2 496 216 | 2 366 285 | 2 366 285 | 23 445.00 | 2 342 840 | 0.99 | 2 343 728 | 5 974 | 2 153 373 | 35 | 14 716 |
| Serbia[6, 20] | 98 729 | 92 617 | 92 617 | 4 931.17 | 87 686 | 5.32 | 90 178 | 4 405 | 68 596 | 15 | 241 |
| Slovak Republic | 84 242 | 81 945 | 81 890 | 1 042.00 | 80 848 | 1.27 | 80 626 | 7 346 | 77 067 | 109 | 1 341 |
| Spain[1, 19] | 454 064 | 418 005 | 418 005 | 1 639.00 | 416 366 | 0.39 | 412 829 | 10 791 | 344 372 | 591 | 25 619 |
| Castilla-Leon | 24 210 | 21 580 | 21 580 | 109.00 | 21 471 | 0.51 | 20 950 | 1 490 | 18 224 | 95 | 1 057 |
| Catalonia | 62 946 | 61 829 | 61 829 | 576.00 | 61 253 | 0.93 | 59 609 | 1 516 | 50 484 | 61 | 1 847 |
| Basque Country | 18 160 | 17 753 | 17 753 | 15.00 | 17 738 | 0.08 | 18 059 | 3 885 | 16 978 | 56 | 252 |
| Sweden[2] | 109 482 | 112 258 | 112 258 | 1 614.86 | 110 643 | 1.44 | 113 511 | 4 624 | 107 104 | 144 | 3 085 |
| Switzerland | 83 247 | 81 020 | 81 020 | 2 760.43 | 78 260 | 3.41 | 80 011 | 8 420 | 86 491 | 194 | 893 |
| Thailand | 927 070 | 778 267 | 778 267 | 7 597.00 | 770 670 | 0.98 | 770 109 | 5 236 | 637 076 | 5 | 563 |
| Tunisia[4] | 164 758 | 164 758 | 164 758 | 553.00 | 164 205 | 0.34 | 163 555 | 4 721 | 150 875 | 1 | 31 |
| Turkey | 1 351 492 | 725 030 | 725 030 | 5 328.10 | 719 702 | 0.73 | 719 702 | 4 855 | 481 279 | 0 | 0 |
| United Kingdom | 768 180 | 736 785 | 736 785 | 24 773.08 | 712 012 | 3.36 | 710 203 | 9 535 | 698 579 | 270 | 15 062 |
| Scotland | 65 913 | 63 950 | 63 950 | 917.00 | 63 033 | 1.43 | 62 814 | 2 723 | 58 559 | 39 | 715 |
| United States | 3 979 116 | 3 979 116 | 3 979 116 | 0.00 | 3 979 116 | 0.00 | 3 774 330 | 5 456 | 3 147 089 | 534 | 246 991 |
| Uruguay | 53 948 | 40 023 | 40 023 | 58.73 | 39 964 | 0.15 | 42 677 | 5 835 | 33 775 | 18 | 80 |

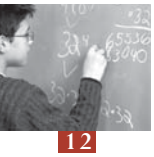
*For notes, please see the end of the chapter.*



## Table 12.1 ■ Sampling and coverage rates (*continued*)

| | Ineligible | | Eligible | | Within-school exclusions (%) | Overall exclusions (%) | Ineligible (%) | Coverage indices | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Actual | Weighted | Actual | Weighted | | | | 1 | 2 | 3 | 4 | 5 |
| Australia | 562 | 7 886 | 15 733 | 239 203 | 1.51 | 2.15 | 3.30 | 0.98 | 0.97 | 0.88 | 0.87 | 1.12 |
| Austria | 146 | 2 159 | 6 306 | 87 030 | 1.26 | 1.62 | 2.48 | 0.98 | 0.98 | 0.91 | 0.99 | 0.99 |
| Belgium | 154 | 1 634 | 9 600 | 113 024 | 1.06 | 1.53 | 1.45 | 0.98 | 0.98 | 0.93 | 0.96 | 1.00 |
| Brazil | 334 | 137 164 | 4 876 | 1 954 395 | 0.11 | 0.11 | 7.02 | 1.00 | 0.99 | 0.54 | 0.84 | 1.00 |
| Canada[9] | 1 638 | 18 439 | 34 582 | 348 764 | 5.26 | 6.83 | 5.29 | 0.93 | 0.93 | 0.83 | 0.93 | 0.96 |
| Czech Republic[11] | 52 | 919 | 7 070 | 121 401 | 0.18 | 1.20 | 0.76 | 0.99 | 0.99 | 0.93 | 0.98 | 0.99 |
| Denmark[14] | 88 | 980 | 4 906 | 54 062 | 4.29 | 5.33 | 1.81 | 0.95 | 0.95 | 0.87 | 0.96 | 0.98 |
| Finland[12] | 32 | 303 | 6 314 | 58 608 | 1.24 | 3.38 | 0.52 | 0.97 | 0.97 | 0.95 | 0.98 | 1.00 |
| France | 66 | 10 490 | 5 026 | 742 737 | 1.10 | 3.40 | 1.41 | 0.97 | 0.93 | 0.91 | 0.98 | 1.00 |
| Germany[15] | 84 | 14 555 | 5 150 | 895 891 | 1.29 | 1.89 | 1.62 | 0.98 | 0.98 | 0.93 | 0.99 | 0.99 |
| Greece[7, 13] | 86 | 1 707 | 4 998 | 107 783 | 2.46 | 3.19 | 1.58 | 0.97 | 0.97 | 0.94 | 1.05 | 0.95 |
| Hong Kong-China | 91 | 1 370 | 4 974 | 72 587 | 0.14 | 0.97 | 1.89 | 0.99 | 0.99 | 0.97 | 1.00 | 1.00 |
| Hungary | 134 | 3 225 | 5 197 | 108 109 | 0.99 | 3.94 | 2.98 | 0.96 | 0.96 | 0.83 | 0.91 | 0.98 |
| Iceland | 104 | 104 | 4 003 | 4 007 | 1.97 | 2.59 | 2.60 | 0.97 | 0.97 | 0.94 | 0.98 | 1.00 |
| Indonesia[5] | 80 | 18 841 | 10 960 | 1 971 476 | 0.00 | 0.31 | 0.96 | 1.00 | 0.95 | 0.46 | 0.91 | 0.73 |
| Ireland[17] | 129 | 1 462 | 4 871 | 56 469 | 2.87 | 4.29 | 2.59 | 0.96 | 0.96 | 0.89 | 0.97 | 1.01 |
| Italy[1] | 355 | 18 559 | 12 595 | 488 315 | 1.39 | 1.88 | 3.80 | 0.98 | 0.98 | 0.86 | 0.87 | 0.98 |
| Veneto - NE | 27 | 526 | 1 662 | 31 270 | 1.33 | 1.99 | 1.68 | 0.98 | 0.98 | 0.82 | 0.89 | 0.97 |
| Trento - NE | 24 | 56 | 1 098 | 3 397 | 2.16 | 3.95 | 1.66 | 0.96 | 0.96 | 0.73 | 0.86 | 0.96 |
| Toscana - Centro | 41 | 609 | 1 638 | 26 068 | 1.33 | 1.87 | 2.33 | 0.98 | 0.98 | 0.95 | 0.92 | 0.97 |
| Piemonte - NW | 53 | 979 | 1 688 | 30 628 | 1.70 | 2.25 | 3.20 | 0.98 | 0.98 | 0.90 | 0.91 | 1.01 |
| Lombardia - NW | 44 | 1 929 | 1 658 | 65 953 | 3.09 | 3.41 | 2.92 | 0.97 | 0.97 | 0.84 | 0.91 | 0.97 |
| Bolzano - NE | 19 | 59 | 1 343 | 3 531 | 1.90 | 2.11 | 1 .68 | 0.98 | 0.98 | 0.71 | 0.89 | 0.97 |
| Japan | 19 | 4 699 | 4 951 | 1 240 054 | 0.00 | 1.02 | 0.38 | 0.99 | 0.99 | 0.91 | 0.94 | 1.00 |
| Korea | 67 | 6 493 | 5 533 | 535 787 | 0.43 | 0.87 | 1.21 | 0.99 | 0.99 | 0.88 | 0.87 | 1.02 |
| Latvia | 69 | 538 | 4 984 | 34 023 | 1.12 | 4.89 | 1.58 | 0.95 | 0.95 | 0.90 | 0.96 | 0.99 |
| Liechtenstein | 2 | 2 | 343 | 343 | 1.46 | 1.46 | 0.58 | 0.99 | 0.99 | 0.84 | 0.99 | 1.00 |
| Luxembourg[16] | 51 | 51 | 4 143 | 4 146 | 1.59 | 1.59 | 1.23 | 0.98 | 0.98 | 0.97 | 1.01 | 0.97 |
| Macao-China | 55 | 204 | 1 278 | 6 559 | 0.20 | 0.20 | 3.10 | 1.00 | 1.00 | 0.79 | 0.94 | 1.01 |
| Mexico[23] | 2 032 | 87 407 | 32 890 | 1 078 914 | 0.67 | 4.30 | 8.10 | 0.96 | 0.96 | 0.49 | 0.90 | 0.98 |
| Netherlands[3] | 46 | 1 942 | 4 547 | 185 984 | 0.56 | 1.87 | 1.04 | 0.98 | 0.98 | 0.95 | 0.95 | 1.02 |
| New Zealand | 337 | 3 056 | 5 582 | 51 049 | 4.72 | 5.07 | 5.99 | 0.95 | 0.95 | 0.88 | 0.96 | 1.00 |
| Norway | 38 | 429 | 4 789 | 54 380 | 2.87 | 3.39 | 0.79 | 0.97 | 0.96 | 0.94 | 0.99 | 0.99 |
| Poland | 15 | 1 440 | 5 476 | 542 417 | 1.39 | 3.91 | 0.27 | 0.96 | 0.96 | 0.91 | 0.97 | 1.01 |
| Portugal[8] | 305 | 5 581 | 5 321 | 98 307 | 1.47 | 2.30 | 5.68 | 0.98 | 0.98 | 0.89 | 0.92 | 1.09 |
| Russian Federation[10] | 69 | 22 994 | 6 288 | 2 168 089 | 0.68 | 1.66 | 1.06 | 0.98 | 0.98 | 0.86 | 0.93 | 1.00 |
| Serbia[6, 20] | 294 | 3 949 | 4 844 | 68 837 | 0.35 | 5.66 | 5.74 | 0.94 | 0.94 | 0.69 | 0.76 | 1.03 |
| Slovak Republic | 57 | 640 | 8 103 | 78 408 | 1.71 | 2.96 | 0.82 | 0.97 | 0.97 | 0.91 | 0.97 | 1.00 |
| Spain[1, 19] | 80 | 999 | 12 246 | 369 991 | 6.92 | 7.29 | 0.27 | 0.93 | 0.93 | 0.76 | 0.90 | 0.99 |
| Castilla-Leon | 5 | 58 | 1 695 | 19 281 | 5.48 | 5.96 | 0.30 | 0.94 | 0.94 | 0.75 | 0.92 | 0.98 |
| Catalonia | 7 | 234 | 1 695 | 52 331 | 3.53 | 4.43 | 0.45 | 0.96 | 0.96 | 0.80 | 0.88 | 0.97 |
| Basque Country | 60 | 275 | 4 128 | 17 231 | 1.46 | 1.55 | 1.59 | 0.98 | 0.98 | 0.93 | 0.95 | 1.02 |
| Sweden[2] | 35 | 764 | 5 114 | 110 189 | 2.80 | 4.20 | 0.69 | 0.96 | 0.96 | 0.98 | 0.97 | 1.03 |
| Switzerland | 144 | 1 731 | 9 086 | 87 384 | 1.02 | 4.39 | 1.98 | 0.96 | 0.96 | 1.04 | 1.09 | 1.02 |
| Thailand | 116 | 14 984 | 5 344 | 637 639 | 0.09 | 1.06 | 2.35 | 0.99 | 0.99 | 0.69 | 0.83 | 1.00 |
| Tunisia[4] | 312 | 9 596 | 4 903 | 150 906 | 0.02 | 0.36 | 6.36 | 1.00 | 1.00 | 0.92 | 0.92 | 1.00 |
| Turkey | 95 | 9 925 | 5 010 | 481 279 | 0.00 | 0.73 | 2.06 | 0.99 | 0.99 | 0.36 | 0.67 | 1.00 |
| United Kingdom | 422 | 26 177 | 12 303 | 713 641 | 2.11 | 5.40 | 3.67 | 0.95 | 0.95 | 0.91 | 1.00 | 1.00 |
| Scotland | 129 | 2 234 | 3 268 | 59 273 | 1.21 | 2.62 | 3.77 | 0.97 | 0.97 | 0.89 | 0.94 | 1.00 |
| United States | 261 | 124 279 | 7 337 | 3 394 080 | 7.28 | 7.28 | 3.66 | 0.93 | 0.93 | 0.79 | 0.90 | 0.95 |
| Uruguay | 622 | 2 635 | 6528 | 33855 | 0.24 | 0.38 | 7.78 | 1.00 | 1.00 | 0.63 | 0.79 | 1.07 |

*For notes, please see the end of the chapter.*





field, were omitted from the calculation of response rates. Replacement schools do not figure in these calculations.

In calculating weighted school response rates, each school received a weight equal to the product of its base weight (the reciprocal of its selection probability) and the number of age-eligible students enrolled, as indicated on the sampling frame.

With the use of probability proportional-to-size sampling, in countries with few certainty school selections and no over-sampling or under-sampling of any explicit strata, weighted and unweighted rates are very similar. Thus, the weighted school response rate before replacement is given by the formula:

$$\begin{matrix} weighted\ school\ response\ rate \\ before\ replacement \end{matrix} = \frac{\sum_{i \in Y} W_i E_i}{\sum_{i \in (Y \cup N)} W_i E_i} \qquad (12.1)$$

where $Y$ denotes the set of responding original sample schools with age-eligible students, $N$ denotes the set of eligible non-responding original sample schools, $W_i$ denotes the base weight for school $i$, $W_i = 1/P_i$ where $P_i$ denotes the school selection probability for school $i$, and $E_i$ denotes the enrolment size of age-eligible students, as indicated on the sampling frame.

The weighted school response rate, after replacement, is given by the formula:

$$\begin{matrix} weighted\ school\ response\ rate \\ after\ replacement \end{matrix} = \frac{\sum_{i \in (Y \cup R)} W_i E_i}{\sum_{i \in (Y \cup R \cup N)} W_i E_i} \qquad (12.2)$$

where $Y$ denotes the set of responding original sample schools, $R$ denotes the set of responding replacement schools, for which the corresponding original sample school was eligible but was non-responding, $N$ denotes the set of eligible refusing original sample schools which were not replaced, $W_i$ denotes the base weight for school $i$, $W_i = 1/P_i$, where $P_i$ denotes the school selection probability for school $i$, and for weighted rates, $E_i$ denotes the enrolment size of age-eligible students, as indicated on the sampling frame.

For unweighted student response rates, the numerator is the number of students for whom assessment data were included in the results, less those in schools with between 25 and 50 per cent student participation. The denominator is the number of sampled students who were age-eligible, and not explicitly excluded as student exclusions, nor part of schools with student participation between 25 and 50 per cent. The exception is cases where countries applied different sampling rates across explicit strata.

For weighted student response rates, the same number of students appears in the numerator and denominator as for unweighted rates, but each student was weighted by its student base weight. This is given as the product of the school base weight—for the school in which the student is enrolled—and the reciprocal of the student selection probability within the school.

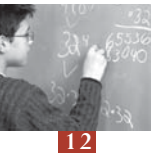
In countries with no over-sampling of any explicit strata, weighted and unweighted student participation rates are very similar.

Overall response rates are calculated as the product of school and student response rates. Although overall weighted and unweighted rates can be calculated, there is little value in presenting overall unweighted



## Table 12.2 ■ School response rates before replacements

| | Weighted school participation rate before replacement (%) | Weighted number of responding schools *(also weighted by enrolment)* | Weighted number of schools sampled, responding and non-responding *(also weighted by enrolment)* | Unweighted school participation rate before replacement (%) | Number of Responding Schools *(unweighted)* | Number of responding and non-responding schools *(unweighted)* |
|---|---|---|---|---|---|---|
| **Australia** | 86.31 | 237 525 | 275 208 | 84.79 | 301 | 355 |
| **Austria** | 99.29 | 87 169 | 87 795 | 98.97 | 192 | 194 |
| **Belgium** | 83.40 | 98 423 | 118 010 | 83.78 | 248 | 296 |
| **Brazil** | 93.20 | 2 181 287 | 2 340 538 | 93.01 | 213 | 229 |
| **Canada** | 79.95 | 300 328 | 375 622 | 89.50 | 1 040 | 1 162 |
| **Czech Republic** | 91.38 | 113 178 | 123 855 | 91.22 | 239 | 262 |
| **Denmark** | 84.60 | 47 573 | 56 234 | 83.33 | 175 | 210 |
| **Finland** | 97.39 | 58 209 | 59 766 | 97.97 | 193 | 197 |
| **France** | 88.65 | 671 417 | 757 355 | 88.52 | 162 | 183 |
| **Germany** | 98.06 | 886 841 | 904 387 | 97.69 | 211 | 216 |
| **Greece** | 80.60 | 82 526 | 102 384 | 81.01 | 145 | 179 |
| **Hong Kong-China** | 81.89 | 59 216 | 72 312 | 82.12 | 124 | 151 |
| **Hungary** | 97.32 | 115 041 | 118 207 | 94.66 | 248 | 262 |
| **Iceland** | 99.90 | 4 082 | 4 086 | 98.47 | 129 | 131 |
| **Indonesia** | 100.00 | 2 173 824 | 2 173 824 | 100.00 | 344 | 344 |
| **Ireland** | 90.24 | 52 791 | 58 499 | 90.26 | 139 | 154 |
| **Italy** | 97.54 | 549 168 | 563 039 | 98.03 | 398 | 406 |
| **Veneto – NE** | 97.97 | 34 344 | 35 056 | 98.08 | 51 | 52 |
| **Trento – NE** | 100.00 | 3 962 | 3 962 | 100.00 | 33 | 33 |
| **Toscana-Cntr** | 95.93 | 27 120 | 28 272 | 96.15 | 50 | 52 |
| **Piemonte-NW** | 96.12 | 32 249 | 33 552 | 96.49 | 55 | 57 |
| **Lombardia-NW** | 100.00 | 72 657 | 72 657 | 100.00 | 52 | 52 |
| **Bolzano - NE** | 100.00 | 3 967 | 3 967 | 100.00 | 43 | 43 |
| **Japan** | 87.12 | 1 144 942 | 1 314 227 | 87.33 | 131 | 150 |
| **Korea** | 95.89 | 589 540 | 614 825 | 95.97 | 143 | 149 |
| **Latvia** | 95.31 | 33 845 | 35 509 | 95.73 | 157 | 164 |
| **Liechtenstein** | 100.00 | 348 | 348 | 100.00 | 12 | 12 |
| **Luxembourg** | 99.93 | 4 087 | 4 090 | 90.63 | 29 | 32 |
| **Macao-China** | 100.00 | 6 992 | 6 992 | 100.00 | 39 | 39 |
| **Mexico** | 93.98 | 1 132 315 | 1 204 851 | 94.45 | 1 090 | 1 154 |
| **Netherlands** | 82.61 | 161 682 | 195 725 | 82.29 | 144 | 175 |
| **New Zealand** | 91.09 | 48 401 | 53 135 | 90.29 | 158 | 175 |
| **Norway** | 87.87 | 48 219 | 54 874 | 87.50 | 175 | 200 |
| **Poland** | 95.12 | 531 479 | 558 752 | 94.58 | 157 | 166 |
| **Portugal** | 99.31 | 106 174 | 106 916 | 99.35 | 152 | 153 |
| **Russian Federation** | 99.51 | 1 798 096 | 1 806 954 | 99.53 | 210 | 211 |
| **Serbia** | 100.00 | 90 178 | 90 178 | 100.00 | 149 | 149 |
| **Slovak Republic** | 78.92 | 63 629 | 80 626 | 78.52 | 223 | 284 |
| **Spain** | 98.39 | 406 170 | 412 829 | 98.43 | 377 | 383 |
| **Castilla-Leon** | 98.45 | 20 625 | 20 950 | 98.04 | 50 | 51 |
| **Catalonia** | 97.95 | 58 385 | 59 609 | 98.00 | 49 | 50 |
| **Basque Country** | 98.58 | 17 802.53 | 1 8059.02 | 98.58 | 139 | 141 |
| **Sweden** | 99.08 | 112 467 | 113 511 | 98.40 | 185 | 188 |
| **Switzerland** | 97.32 | 77 867 | 80 011 | 95.83 | 437 | 456 |
| **Thailand** | 91.46 | 704 344 | 770 109 | 91.06 | 163 | 179 |
| **Tunisia** | 100.00 | 163 555 | 163 555 | 100.00 | 149 | 149 |
| **Turkey** | 93.29 | 671 385 | 719 702 | 91.20 | 145 | 159 |
| **United Kingdom** | 64.32 | 456 818 | 710 203 | 68.96 | 311 | 451 |
| **Scotland** | 78.32 | 49 198 | 62 814 | 77.78 | 84 | 108 |
| **United States** | 64.94 | 2 451 083 | 3 774 330 | 65.18 | 249 | 382 |
| **Uruguay** | 93.20 | 39 773 | 42 677 | 95.10 | 233 | 245 |





rates. The weighted rates indicate the proportion of the student population represented by the sample prior to making the school and student non-response adjustments.

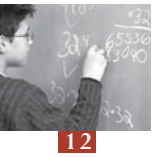
Table 12.3 ■ **School response rates after replacement**

| | Weighted school participation rate after replacement (%) | Weighted number of responding schools *(also weighted by enrolment)* | Weighted number of schools sampled, responding and non-responding *(also weighted by enrolment)* | Unweighted school participation rate after all replacement (%) | Number of responding schools *(unweighted)* | Number of responding and non-responding schools *(unweighted)* |
|---|---|---|---|---|---|---|
| **Australia** | 90.43 | 248 876 | 275 208 | 88.45 | 314 | 355 |
| **Austria** | 99.29 | 87 169 | 87 795 | 98.97 | 192 | 194 |
| **Belgium** | 95.63 | 112 775 | 117 924 | 95.27 | 282 | 296 |
| **Brazil** | 99.51 | 2 328 972 | 2 340 538 | 99.56 | 228 | 229 |
| **Canada** | 84.38 | 316 977 | 375 638 | 91.74 | 1 066 | 1 162 |
| **Czech Republic** | 99.05 | 122 629 | 123 811 | 98.86 | 259 | 262 |
| **Denmark** | 98.32 | 55 271 | 56 213 | 97.62 | 205 | 210 |
| **Finland** | 100.00 | 59 766 | 59 766 | 100.00 | 197 | 197 |
| **France** | 89.24 | 675 840 | 757 355 | 89.07 | 163 | 183 |
| **Germany** | 98.82 | 893 879 | 904 559 | 98.61 | 213 | 216 |
| **Greece** | 95.77 | 104 859 | 109 490 | 95.53 | 171 | 179 |
| **Hong Kong-China** | 95.90 | 69 345 | 72 312 | 96.03 | 145 | 151 |
| **Hungary** | 99.37 | 117 269 | 118 012 | 96.18 | 252 | 262 |
| **Iceland** | 99.90 | 4 082 | 4 086 | 98.47 | 129 | 131 |
| **Indonesia** | 100.00 | 2 173 824 | 2 173 824 | 100.00 | 344 | 344 |
| **Ireland** | 92.84 | 54 310 | 58 499 | 92.86 | 143 | 154 |
| **Italy** | 100.00 | 563 039 | 563 039 | 100.00 | 406 | 406 |
| **Veneto – NE** | 100.00 | 35 056 | 35 056 | 100.00 | 52 | 52 |
| **Trento – NE** | 100.00 | 3 962 | 3 962 | 100.00 | 33 | 33 |
| **Toscana - Cntr** | 100.00 | 28 272 | 28 272 | 100.00 | 52 | 52 |
| **Piemonte – NW** | 100.00 | 33 552 | 33 552 | 100.00 | 57 | 57 |
| **Lombardia – NW** | 100.00 | 72 657 | 72 657 | 100.00 | 52 | 52 |
| **Bolzano – NE** | 100.00 | 3 967 | 3 967 | 100.00 | 43 | 43 |
| **Japan** | 95.91 | 1 260 428 | 1 314 227 | 96.00 | 144 | 150 |
| **Korea** | 100.00 | 614 825 | 614 825 | 100.00 | 149 | 149 |
| **Latvia** | 95.31 | 33 845 | 35 509 | 95.73 | 157 | 164 |
| **Liechtenstein** | 100.00 | 348 | 348 | 100.00 | 12 | 12 |
| **Luxembourg** | 99.93 | 4 087 | 4 090 | 90.63 | 29 | 32 |
| **Macao-China** | 100.00 | 6 992 | 6 992 | 100.00 | 39 | 39 |
| **Mexico** | 95.45 | 1 150 023 | 1 204 851 | 95.49 | 1 102 | 1 154 |
| **Netherlands** | 87.86 | 171 955 | 195 725 | 87.43 | 153 | 175 |
| **New Zealand** | 97.55 | 51 842 | 53 145 | 97.71 | 171 | 175 |
| **Norway** | 90.40 | 49 608 | 54 874 | 90.00 | 180 | 200 |
| **Poland** | 98.09 | 548 168 | 558 853 | 98.19 | 163 | 166 |
| **Portugal** | 99.31 | 106 174 | 106 916 | 99.35 | 152 | 153 |
| **Russian Federation** | 100.00 | 1 806 954 | 1 806 954 | 100.00 | 211 | 211 |
| **Serbia** | 100.00 | 90 178 | 90 178 | 100.00 | 149 | 149 |
| **Slovak Republic** | 99.08 | 80 394 | 81 141 | 98.94 | 281 | 284 |
| **Spain** | 100.00 | 412 777 | 412 777 | 100.00 | 383 | 383 |
| **Castilla-Leon** | 100.00 | 20 911 | 20 911 | 100.00 | 51 | 51 |
| **Catalonia** | 100.00 | 59 609 | 59 609 | 100.00 | 50 | 50 |
| **Basque Country** | 100.00 | 18 047 | 18 047 | 100.00 | 141 | 141 |
| **Sweden** | 99.08 | 112 467 | 113 511 | 98.40 | 185 | 188 |
| **Switzerland** | 98.53 | 78 838 | 80 014 | 97.39 | 444 | 456 |
| **Thailand** | 100.00 | 769 392 | 769 392 | 100.00 | 179 | 179 |
| **Tunisia** | 100.00 | 163 555 | 163 555 | 100.00 | 149 | 149 |
| **Turkey** | 100.00 | 719 405 | 719 405 | 100.00 | 159 | 159 |
| **United Kingdom** | 77.37 | 549 059 | 709 641 | 80.04 | 361 | 451 |
| **Scotland** | 88.89 | 55 737 | 62 794 | 88.89 | 96 | 108 |
| **United States** | 68.12 | 2 571 003 | 3 774 322 | 68.59 | 262 | 382 |
| **Uruguay** | 97.11 | 41 474 | 42 709 | 97.55 | 239 | 245 |



## Table 12.4 ■ Student response rates after replacements

| | Weighted student participation rate after replacements (%) | Number of students assessed *(weighted)* | Number of students sampled *(assessed + absent) (weighted)* | Unweighted student participation rate after replacements (%) | Number of students assessed *(unweighted)* | Number of students sampled *(assessed + absent) (unweighted)* |
|---|---|---|---|---|---|---|
| **Australia** | 83.31 | 176 085.48 | 211 356.99 | 81.86 | 12 425 | 15 179 |
| **Austria** | 83.56 | 71 392.31 | 85 438.77 | 73.50 | 4 566 | 6 212 |
| **Belgium** | 92.47 | 98 935.93 | 106 994.65 | 92.61 | 8 796 | 9 498 |
| **Brazil** | 91.19 | 1 772 521.76 | 1 943 751.20 | 91.40 | 4 452 | 4 871 |
| **Canada** | 83.90 | 233 829.33 | 278 714.21 | 86.87 | 27 712 | 31 899 |
| **Czech Republic** | 89.03 | 106 644.57 | 119 791.10 | 89.77 | 6 316 | 7 036 |
| **Denmark** | 89.88 | 45 355.80 | 50 464.41 | 89.95 | 4 216 | 4 687 |
| **Finland** | 92.84 | 53 736.86 | 57 883.49 | 92.96 | 5 796 | 6 235 |
| **France** | 88.11 | 581 956.66 | 660 490.52 | 88.27 | 4 214 | 4 774 |
| **Germany** | 92.18 | 806 312.08 | 874 761.70 | 92.10 | 4 642 | 5 040 |
| **Greece** | 95.43 | 96 272.68 | 100 882.66 | 95.32 | 4 627 | 4 854 |
| **Hong Kong-China** | 90.20 | 62 755.77 | 69 575.73 | 90.17 | 4 478 | 4 966 |
| **Hungary** | 92.87 | 98 996.04 | 106 594.32 | 92.83 | 4 764 | 5 132 |
| **Iceland** | 85.37 | 3 350.00 | 3 924.00 | 85.37 | 3 350 | 3 924 |
| **Indonesia** | 98.09 | 1 933 838.77 | 1 971 476.30 | 98.18 | 10 761 | 10 960 |
| **Ireland** | 82.58 | 42 009.03 | 50 872.56 | 82.48 | 3 852 | 4 670 |
| **Italy** | 92.52 | 445 501.79 | 481 520.75 | 93.81 | 11 639 | 12 407 |
| **Veneto – NE** | 93.84 | 28 953.51 | 30 854.15 | 93.78 | 1 538 | 1 640 |
| **Trento – NE** | 95.97 | 3 189.69 | 3 323.75 | 95.55 | 1 030 | 1 078 |
| **Toscana - Cntr** | 93.04 | 23 930.56 | 25 722.08 | 93.32 | 1 509 | 1 617 |
| **Piemonte – NW** | 94.15 | 28 343.85 | 30 106.54 | 94.22 | 1 565 | 1 661 |
| **Lombardia – NW** | 95.48 | 61 024.16 | 63 915.67 | 95.37 | 1 545 | 1 620 |
| **Bolzano – NE** | 96.13 | 3 330.57 | 3 464.49 | 95.90 | 1 264 | 1 318 |
| **Japan** | 95.08 | 1 132 199.53 | 1 190 767.88 | 95.07 | 4 707 | 4 951 |
| **Korea** | 98.81 | 527 176.77 | 533 504.20 | 98.82 | 5 444 | 5 509 |
| **Latvia** | 93.88 | 300 42.86 | 32 001.41 | 93.66 | 4 627 | 4 940 |
| **Liechtenstein** | 98.22 | 332.00 | 338.00 | 98.22 | 332 | 338 |
| **Luxembourg** | 96.22 | 3 923.00 | 4 077.00 | 96.22 | 3 923 | 4 077 |
| **Macao-China** | 98.02 | 6 641.54 | 6 775.49 | 98.12 | 1 250 | 1 274 |
| **Mexico** | 92.26 | 938 901.78 | 1 017 666.73 | 92.12 | 29 734 | 32 276 |
| **Netherlands** | 88.25 | 144 211.88 | 163 417.98 | 88.46 | 3 979 | 4 498 |
| **New Zealand** | 85.71 | 40 595.43 | 47 362.84 | 85.67 | 4 483 | 5 233 |
| **Norway** | 87.86 | 41 922.64 | 47 714.86 | 87.92 | 4 039 | 4 594 |
| **Poland** | 81.95 | 429 920.50 | 524 583.62 | 81.91 | 4 338 | 5 296 |
| **Portugal** | 87.92 | 84 783.25 | 96 437.01 | 88.29 | 4 590 | 5 199 |
| **Russian Federation** | 95.71 | 2 061 050.06 | 2 153 373.33 | 95.54 | 5 974 | 6 253 |
| **Serbia** | 91.36 | 62 669.13 | 68 596.08 | 91.22 | 4 405 | 4 829 |
| **Slovak Republic** | 91.90 | 70 246.11 | 76 440.84 | 91.89 | 7 346 | 7 994 |
| **Spain** | 90.61 | 312 044.12 | 344 371.96 | 92.59 | 10 791 | 11 655 |
| **Castilla-Leon** | 93.28 | 16 999.74 | 18 223.90 | 93.13 | 1 490 | 1 600 |
| **Catalonia** | 92.95 | 46 922.34 | 50 483.51 | 92.78 | 1 516 | 1 634 |
| **Basque Country** | 95.38 | 16 194.83 | 16 978.49 | 95.41 | 3 885 | 4 072 |
| **Sweden** | 92.61 | 98 095.45 | 105 927.41 | 93.04 | 4 624 | 4 970 |
| **Switzerland** | 94.70 | 81 025.56 | 85 556.04 | 94.76 | 8 415 | 8 880 |
| **Thailand** | 97.81 | 623 092.96 | 637 075.68 | 98.07 | 5 236 | 5 339 |
| **Tunisia** | 96.27 | 145 250.92 | 150 874.89 | 96.31 | 4 721 | 4 902 |
| **Turkey** | 96.87 | 466 200.86 | 481 279.22 | 96.91 | 4 855 | 5 010 |
| **United Kingdom** | 77.92 | 419 810.06 | 538 737.19 | 81.62 | 9 265 | 11 352 |
| **Scotland** | 85.14 | 44 307.83 | 52 041.51 | 85.19 | 2 692 | 3 160 |
| **United States** | 82.73 | 1 772 279.24 | 2 142 287.58 | 82.16 | 5 342 | 6 502 |
| **Uruguay** | 90.83 | 29 755.57 | 32 759.39 | 90.27 | 5 797 | 6 422 |





## DESIGN EFFECT AND EFFECTIVE SAMPLE SIZE

Surveys in education, and especially international surveys, rarely sample students by simply selecting a random sample of students (a simple random sample). Schools are first selected and, within each selected school, classes or students are randomly sampled. Sometimes, geographic areas are first selected before sampling schools and students. This sampling design is usually referred to as a cluster sample or a multi-stage sample.

Selected students attending the same school cannot be considered as independent observations, as they can be with a simple random sample because they are usually more similar than students attending distinct educational institutions. For instance, they are offered the same school resources, may have the same teachers and therefore are taught a common implemented curriculum, and so on. School differences are also larger if different educational programs are not available in all schools. One expects to observe greater differences between a vocational school and an academic school than between two comprehensive schools.

Furthermore, it is well known that within a country, within sub-national entities, and within a city, people tend to live in areas according to their financial resources. As children usually attend schools close to their house, it is likely that students attending the same school come from similar social and economic backgrounds.

A simple random sample of 4 000 students is thus likely to cover the diversity of the population better than a sample of 100 schools with 40 students observed within each school. It follows that the uncertainty associated with any population parameter estimate (*i.e.* standard error) will be larger for a clustered sample than for a simple random sample of the same size.

In the case of a simple random sample, the standard error on a mean estimate is equal to:

$$\sigma_{(\hat{\mu})} = \sqrt{\frac{\sigma^2}{n}} \qquad (12.3)$$

For an infinite population of schools and infinite populations of students within schools, the standard error of a mean estimate for a cluster sample is equal to:

$$\sigma_{(\hat{\mu})} = \sqrt{\frac{\sigma^2_{schools}}{n_{schools}} + \frac{\sigma^2_{within}}{n_{schools}\ n_{students}}} \qquad (12.4)$$

The standard error for a simple random sample is inversely proportional to the number of selected students. The standard error on the mean for a cluster sample is proportional to the variance that lies between clusters (*i.e.* schools) and within clusters and inversely proportional to the number of selected schools and the number of students selected per school.

It is usual to express the decomposition of the total variance into the between school variance and the within school variance by the coefficient of intraclass correlation, also denoted *rho*. Mathematically, this index is equal to

$$Rho = \frac{\sigma^2_{schools}}{\sigma^2_{schools} + \sigma^2_{within}} \qquad (12.5)$$

This index provides an indication of the percentage of variance that lies between schools.



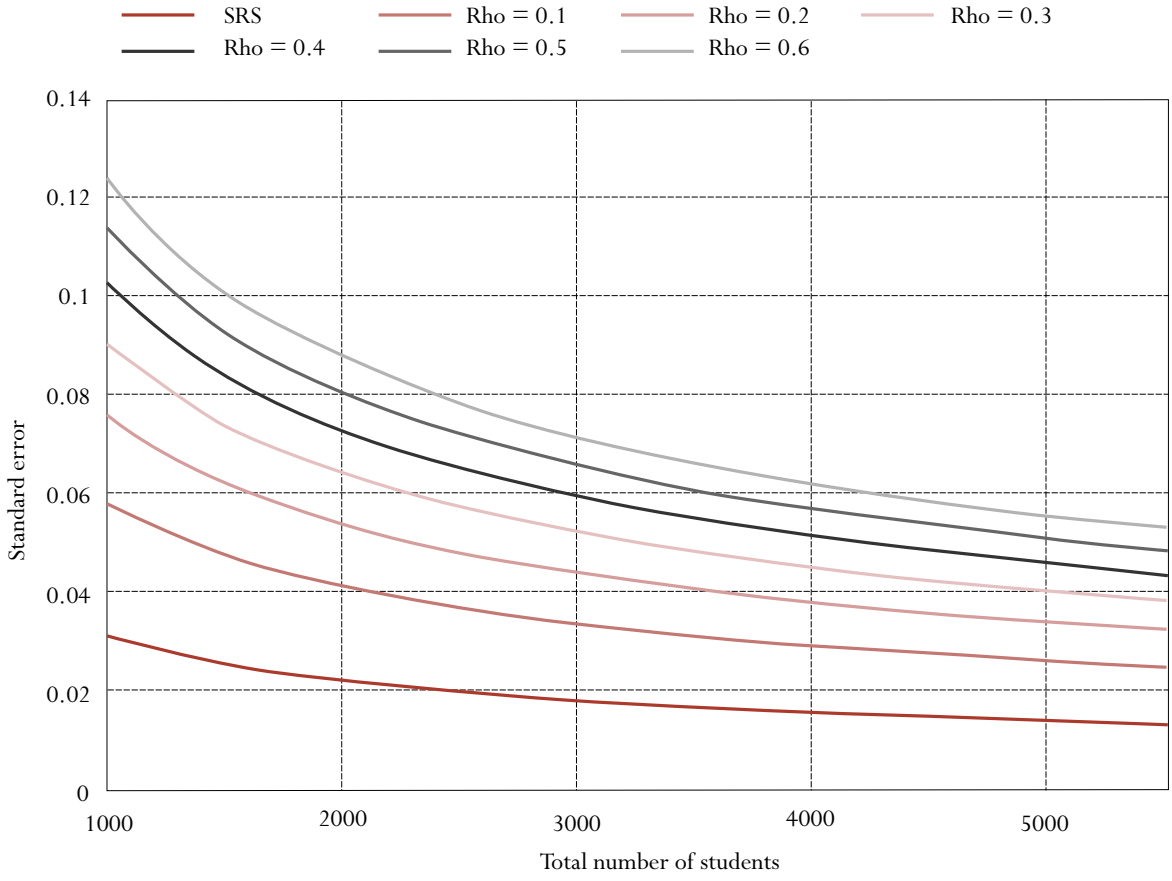
Figure 12.1 shows the standard errors on a mean for a simple random sample of 5 000 students and for cluster samples of 25 students per school for different intraclass correlation coefficients for any standardised variable. In the case of a sample of 25 students, it would mean that 200 schools would have participated.

Figure 12.1 shows that the standard error on the mean is quite a lot larger for a cluster sample than it is for a simple random sample and also that the standard error is proportional of the intraclass correlation.

To limit this reduction of precision in the population parameter estimate, multi-stage sample designs usually use complementary information to improve coverage of the population diversity. In PISA, and in previous international surveys, the following techniques were implemented to limit the increase in the standard error: *i*) explicit and or implicit stratification of the school sample frame, and *ii*) selection of schools with probabilities proportional to their size. Complementary information generally cannot compensate totally for the increase in the standard error due to the multi-stage design however.

Table 12.5 provides the standard errors on the PISA 2003 combined mathematical scale if the country sample was selected according to: *i)* a simple random sample; *ii)* a multistage procedure without using complementary information; and *iii)* the unbiased estimate using the Fay's replicates. It should be mentioned that the plausible value imputation variance was not included in these computations.

Figure 12.1 **Standard error on a mean estimate depending on the intraclass correlation**



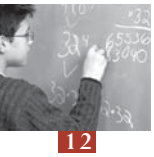




Table 12.5 ■ **Standard errors on the PISA 2003 mathematics scale**

| | SRS | Cluster | Fay's BRR |
|---|---|---|---|
| **Australia** | 0.85 | 2.63 | 2.13 |
| **Austria** | 1.37 | 5.39 | 3.23 |
| **Belgium** | 1.17 | 5.21 | 2.27 |
| **Brazil** | 1.49 | 4.46 | 4.78 |
| **Canada** | 0.52 | 1.34 | 1.78 |
| **Czech Republic** | 1.21 | 4.50 | 3.50 |
| **Denmark** | 1.41 | 2.75 | 2.66 |
| **Finland** | 1.10 | 1.79 | 1.78 |
| **France** | 1.40 | 4.88 | 2.46 |
| **Germany** | 1.50 | 5.42 | 3.31 |
| **Greece** | 1.38 | 4.83 | 3.88 |
| **Hong Kong-China** | 1.50 | 5.74 | 4.43 |
| **Hungary** | 1.35 | 5.13 | 2.77 |
| **Iceland** | 1.56 | 2.43 | 1.37 |
| **Indonesia** | 0.78 | 2.98 | 3.87 |
| **Ireland** | 1.37 | 3.18 | 2.40 |
| **Italy** | 0.89 | 3.68 | 2.97 |
| **Japan** | 1.47 | 6.23 | 3.99 |
| **Korea** | 1.25 | 5.06 | 3.18 |
| **Latvia** | 1.29 | 3.59 | 3.65 |
| **Liechtenstein** | 5.44 | 18.44 | 3.28 |
| **Luxembourg** | 1.47 | 9.92 | 0.96 |
| **Macao-China** | 2.46 | 6.82 | 2.83 |
| **Mexico** | 0.49 | 1.65 | 3.62 |
| **Netherlands** | 1.46 | 6.08 | 3.10 |
| **New Zealand** | 1.46 | 3.52 | 2.16 |
| **Norway** | 1.44 | 2.30 | 2.36 |
| **Poland** | 1.36 | 2.85 | 2.46 |
| **Portugal** | 1.29 | 4.32 | 3.40 |
| **Russian Federation** | 1.19 | 3.70 | 4.15 |
| **Serbia** | 1.28 | 4.31 | 3.69 |
| **Slovak Republic** | 1.09 | 3.80 | 3.32 |
| **Spain** | 0.85 | 2.32 | 2.35 |
| **Sweden** | 1.39 | 2.68 | 2.54 |
| **Switzerland** | 1.07 | 3.02 | 3.34 |
| **Thailand** | 1.13 | 3.98 | 2.94 |
| **Tunisia** | 1.19 | 4.45 | 2.52 |
| **Turkey** | 1.50 | 6.28 | 6.70 |
| **United Kingdom** | 0.94 | 2.61 | 2.38 |
| **United States** | 1.29 | 3.18 | 2.85 |
| **Uruguay** | 1.30 | 4.58 | 3.26 |

In several countries, the Fay's estimate of the standard error is substantially smaller than the estimate of the simple multistage sample. The difference provides an indication of the efficiency of the stratification process for reducing the sampling variance.

It is usual to express the effect of the sampling design on the standard errors by the design effect. It corresponds to the ratio of the variance of the estimate obtained from the (more complex) sample to the variance of the estimate that would be obtained from a simple random sample of the same number of units. The design effect has two primary uses – in sample size estimation and in appraising the efficiency of more complex plans (Cochran, 1977).

In PISA, as sampling variance has to be estimated by using the 80 Fay's replicate, a design effect can be computed for a statistic t using:

$$Deff\ (t) = \frac{Var_{BRR}(t)}{Var_{SRS}(t)} \qquad (12.6)$$

where $Var_{BRR}(t)$ is the sampling variance for the statistic $t$ computed by the BRR replication method, and $Var_{SRS}(t)$ is the sampling variance for the same statistic $t$ on the same data base but considering the sample as a simple random sample.

Based on the data of Table 12.5, the design effect in Australia for the mean estimate in mathematics is therefore equal to:

$$Deff\ (t) = \frac{Var_{BRR}(t)}{Var_{SRS}(t)} = \frac{(2.13)^2}{(0.85)^2} = 6.28 \qquad (12.7)$$

The sampling variance on the mathematics performance mean in Australia is about six times larger than it would have been with a simple random sample of equal size.

Another way to quantify the reduction of precision due to the complex sampling design is through the effective sample size, which expresses the simple random sample size that would give the same sampling variance as the one obtained from the actual complex sample design. The effective sample size for statistic $t$ is equal to:



$$Effn(t) = \frac{n}{Deff(t)} = \frac{n \times Var_{SRS}(t)}{Var_{BRR}(t)} \qquad (12.8)$$

where $n$ is equal to the actual number of units in the sample. The effective sample size in Australia for the mathematics performance mean is equal to:

$$Effn(t) = \frac{n}{Deff(t)} = \frac{n \times Var_{SRS}(t)}{Var_{BRR}(t)} = \frac{12551}{6.28} = 1999 \qquad (12.9)$$

In other words, a simple random sample of 1999 students in Australia would have been as precise as the actual PISA 2003 sample for the estimation of the mathematics performance.

### Variability of the design effect

Neither the design effect nor the effective sample size are a definitive characteristic of a sample. Both depend on the requested statistic and on the variable on which some population parameters are estimated.

As stated previously, the sampling variance for a cluster sample is proportional to the intraclass correlation. In some countries, student performance varies between schools. Students in academic schools usually tend to perform well, while on average, student performance in vocational schools is lower. Let us now suppose that the height of the students was also measured. There are no reasons why students in academic schools should be taller than students in vocational schools, at least if there is no interaction between tracks and gender. For this particular variable, the expected value of the school variance should be equal to zero and therefore, the design effect should tend to one. As the segregation effect differs according to the variable, the design effect will also differ according to the variable.

The second factor that influences the size of the design effect is the requested statistics. It tends to be large for means, proportions, and sums but substantially smaller for bivariate or multivariate statistics such as correlations, regression coefficients and so on.

### Design effects in PISA for performance variables

The notion of design effect as given earlier is extended and produces five design effects to describe the influence of the sampling and test designs on the standard errors for statistics.

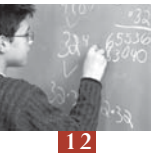
The total errors computed for the international PISA initial report that involves performance variables (plausible values or proficiency levels) consist of two components: sampling variance and measurement variance. The standard error in PISA is inflated because the students were not sampled according to a simple random sample and also because the measure of the student proficiency estimates includes some amount of random error.

For any statistic $t$, the population estimate and the sampling variance are computed for each plausible value and then combined as described in Chapter 9.

The five design effects, and their respective effective sample sizes, are defined as follows:

$$Deff_1(t) = \frac{Var_{SRS}(t) \quad MVar(t)}{Var_{SRS}(t)} \qquad (12.10)$$

where  is the measurement variance for the statistic $t$. This design effect shows the inflation of the total





variance that would have occurred due to measurement error if in fact the sample were considered a simple random sample.

$$Deff_{2}(t) = \frac{Var_{BRR}(t) + MVar(t)}{Var_{SRS}(t) + MVar(t)} \qquad (12.11)$$

shows the inflation of the total variance due only to the use of the complex sampling design.

$$Deff_{3}(t) = \frac{Var_{BRR}(t)}{Var_{SRS}(t)} \qquad (12.12)$$

shows the inflation of the sampling variance due to the use of the complex design.

$$Deff_{4}(t) = \frac{Var_{BRR}(t) + MVar(t)}{Var_{BRR}(t)} \qquad (12.13)$$

shows the inflation of the total variance due to the measurement error.

$$Deff_{5}(t) = \frac{Var_{BRR}(t) + MVar(t)}{Var_{SRS}(t)} \qquad (12.14)$$

shows the inflation of the total variance due to the measurement error and due to the complex sampling design.

The product of the first and second design effects is equal to the product of the third and fourth design effects, and both products are equal to the fifth design effect.

Tables 12.6 to 12.8 provide the design effects and the effective sample sizes, respectively, for the country mean performance in mathematics, reading and science and the design effect for the percentage of students in the mathematic proficiency Level 3.

As previously mentioned, the design effects depend on the computed statistics. Except for Indonesia, Mexico and Turkey, the design effects are usually quite small.

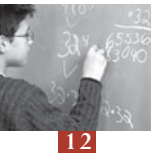
Because the samples for the reading and science scales are drawn from the same schools as that for the combined mathematics scale, but with many fewer students, it follows that the mathematics sample is much more clustered than for the science and reading samples. Therefore it is not surprising to find that design effects are generally substantially higher for mathematics than for reading and science.

The measurement error for the minor domains is not substantially higher than the measurement error for the major domain because the proficiency estimates were generated with a multi-dimensional model using a large set of variables as conditioning variables. This complementary information has effectively reduced the measurement error for the minor domain proficiency estimates.



## Table 12.6 ■ Design effects and effective sample sizes for the mean performance on the mathematical literacy scale

| | Design effect 1 | Design effect 2 | Design effect 3 | Design effect 4 | Design effect 5 | Effective sample size 1 | Effective sample size 2 | Effective sample size 3 | Effective sample size 4 | Effective sample size 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Australia** | 1.11 | 5.75 | 6.26 | 1.02 | 6.36 | 11 335 | 2 184 | 2 006 | 12 339 | 1 973 |
| **Austria** | 1.14 | 4.97 | 5.52 | 1.02 | 5.66 | 4 040 | 924 | 833 | 4 485 | 812 |
| **Belgium** | 1.06 | 3.59 | 3.75 | 1.02 | 3.81 | 8 291 | 2 451 | 2 348 | 8 655 | 2 311 |
| **Brazil** | 1.22 | 8.54 | 10.23 | 1.02 | 10.45 | 3 639 | 521 | 435 | 4 357 | 426 |
| **Canada** | 1.51 | 8.08 | 11.67 | 1.04 | 12.17 | 18 559 | 3 458 | 2 396 | 26 791 | 2 296 |
| **Czech Republic** | 1.21 | 7.13 | 8.42 | 1.02 | 8.63 | 5 221 | 886 | 751 | 6 166 | 732 |
| **Denmark** | 1.24 | 3.07 | 3.57 | 1.07 | 3.81 | 3 402 | 1 373 | 1 182 | 3 952 | 1 108 |
| **Finland** | 1.25 | 2.30 | 2.63 | 1.10 | 2.88 | 4 626 | 2 519 | 2 204 | 5 288 | 2 011 |
| **France** | 1.12 | 2.87 | 3.09 | 1.04 | 3.21 | 3 851 | 1 498 | 1 392 | 4 143 | 1 342 |
| **Germany** | 1.01 | 4.81 | 4.86 | 1.00 | 4.87 | 4 603 | 968 | 959 | 4 648 | 957 |
| **Greece** | 1.10 | 7.25 | 7.89 | 1.01 | 8.00 | 4 192 | 639 | 586 | 4 567 | 579 |
| **Hong Kong-China** | 1.42 | 6.48 | 8.76 | 1.05 | 9.18 | 3 162 | 691 | 511 | 4 275 | 488 |
| **Hungary** | 1.20 | 3.66 | 4.19 | 1.05 | 4.39 | 3 978 | 1 301 | 1 137 | 4 550 | 1 086 |
| **Iceland** | 1.06 | 0.79 | 0.77 | 1.08 | 0.83 | 3 164 | 4 267 | 4 337 | 3 113 | 4 030 |
| **Indonesia** | 1.46 | 17.38 | 24.90 | 1.02 | 25.36 | 7 375 | 619 | 432 | 10 566 | 424 |
| **Ireland** | 1.11 | 2.87 | 3.09 | 1.04 | 3.20 | 3 483 | 1 351 | 1 258 | 3 742 | 1 213 |
| **Italy** | 1.78 | 6.77 | 11.24 | 1.07 | 12.02 | 6 556 | 1 719 | 1 035 | 10 888 | 968 |
| **Japan** | 1.09 | 6.87 | 7.42 | 1.01 | 7.51 | 4 308 | 685 | 635 | 4 649 | 627 |
| **Korea** | 1.22 | 5.48 | 6.47 | 1.03 | 6.69 | 4 457 | 994 | 842 | 5 264 | 814 |
| **Latvia** | 1.18 | 6.90 | 7.96 | 1.02 | 8.14 | 3 920 | 671 | 581 | 4 524 | 568 |
| **Liechtenstein** | 1.21 | 0.47 | 0.36 | 1.58 | 0.57 | 274 | 699 | 910 | 211 | 578 |
| **Luxembourg** | 1.01 | 0.43 | 0.43 | 1.03 | 0.44 | 3 872 | 9 055 | 9 215 | 3 805 | 8 937 |
| **Macao-China** | 1.05 | 1.31 | 1.33 | 1.04 | 1.38 | 1 189 | 955 | 943 | 1 204 | 908 |
| **Mexico** | 1.59 | 34.25 | 53.92 | 1.01 | 54.51 | 18 841 | 875 | 556 | 29 658 | 550 |
| **Netherlands** | 1.09 | 4.21 | 4.48 | 1.02 | 4.57 | 3 676 | 949 | 890 | 3 917 | 874 |
| **New Zealand** | 1.21 | 1.97 | 2.17 | 1.09 | 2.38 | 3 742 | 2 287 | 2 076 | 4 121 | 1 897 |
| **Norway** | 1.03 | 2.63 | 2.68 | 1.01 | 2.71 | 3 946 | 1 545 | 1 517 | 4 019 | 1 500 |
| **Poland** | 1.13 | 3.00 | 3.25 | 1.04 | 3.38 | 3 894 | 1 462 | 1 349 | 4 220 | 1 299 |
| **Portugal** | 1.02 | 6.84 | 6.94 | 1.00 | 6.96 | 4 534 | 673 | 664 | 4 597 | 662 |
| **Russian Federation** | 1.28 | 9.66 | 12.09 | 1.02 | 12.37 | 4 667 | 618 | 494 | 5 839 | 483 |
| **Serbia** | 1.29 | 6.73 | 8.38 | 1.03 | 8.66 | 3 424 | 654 | 526 | 4 259 | 508 |
| **Slovak Republic** | 1.14 | 8.32 | 9.32 | 1.01 | 9.45 | 6 466 | 883 | 788 | 7 240 | 777 |
| **Spain** | 1.36 | 5.87 | 7.64 | 1.05 | 8.00 | 7 918 | 1 838 | 1 413 | 10 302 | 1 348 |
| **Sweden** | 1.06 | 3.18 | 3.31 | 1.02 | 3.37 | 4 362 | 1 454 | 1 396 | 4 542 | 1 371 |
| **Switzerland** | 1.28 | 7.80 | 9.68 | 1.03 | 9.96 | 6 596 | 1 080 | 870 | 8 186 | 846 |
| **Thailand** | 1.25 | 5.59 | 6.75 | 1.04 | 7.01 | 4 177 | 937 | 775 | 5 047 | 747 |
| **Tunisia** | 1.05 | 4.30 | 4.47 | 1.01 | 4.52 | 4 497 | 1 097 | 1 057 | 4 669 | 1 045 |
| **Turkey** | 1.24 | 16.15 | 19.84 | 1.01 | 20.08 | 3 905 | 301 | 245 | 4 796 | 242 |
| **United Kingdom** | 1.26 | 5.25 | 6.34 | 1.04 | 6.60 | 7 588 | 1 816 | 1 504 | 9 164 | 1 446 |
| **United States** | 1.36 | 3.85 | 4.87 | 1.07 | 5.23 | 4 014 | 1 418 | 1 120 | 5 081 | 1 043 |
| **Uruguay** | 1.10 | 5.77 | 6.24 | 1.02 | 6.34 | 5 308 | 1 012 | 935 | 5 744 | 920 |





## Table 12.7 ■ Design effects and effective sample sizes for the mean performance on the combined reading literacy scale

| | Design effect 1 | Design effect 2 | Design effect 3 | Design effect 4 | Design effect 5 | Effective sample size 1 | Effective sample size 2 | Effective sample size 3 | Effective sample size 4 | Effective sample size 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Australia** | 1.22 | 4.92 | 5.77 | 1.04 | 5.99 | 10 328 | 2 548 | 2 175 | 12 100 | 2 097 |
| **Austria** | 1.10 | 5.58 | 6.02 | 1.02 | 6.11 | 4 195 | 824 | 764 | 4 525 | 752 |
| **Belgium** | 1.12 | 4.33 | 4.73 | 1.03 | 4.85 | 7 861 | 2 031 | 1 860 | 8 580 | 1 815 |
| **Brazil** | 1.37 | 5.49 | 7.17 | 1.05 | 7.54 | 3 244 | 810 | 621 | 4 232 | 591 |
| **Canada** | 1.49 | 7.29 | 10.39 | 1.05 | 10.89 | 18 723 | 3 833 | 2 690 | 26 687 | 2 568 |
| **Czech Republic** | 1.35 | 6.15 | 7.96 | 1.04 | 8.31 | 4 681 | 1 027 | 794 | 6 054 | 761 |
| **Denmark** | 1.39 | 3.09 | 3.90 | 1.10 | 4.30 | 3 032 | 1 366 | 1 080 | 3 834 | 982 |
| **Finland** | 1.16 | 2.06 | 2.22 | 1.07 | 2.38 | 5 009 | 2 820 | 2 609 | 5 413 | 2 437 |
| **France** | 1.16 | 2.83 | 3.12 | 1.05 | 3.28 | 3 707 | 1 522 | 1 379 | 4 090 | 1 312 |
| **Germany** | 1.05 | 4.29 | 4.44 | 1.01 | 4.49 | 4 454 | 1 087 | 1 050 | 4 612 | 1 039 |
| **Greece** | 1.52 | 4.70 | 6.60 | 1.08 | 7.12 | 3 054 | 985 | 701 | 4 292 | 650 |
| **Hong Kong-China** | 1.07 | 7.88 | 8.39 | 1.01 | 8.46 | 4 171 | 568 | 534 | 4 439 | 529 |
| **Hungary** | 1.12 | 3.08 | 3.32 | 1.03 | 3.43 | 4 271 | 1 548 | 1 436 | 4 605 | 1 388 |
| **Iceland** | 1.14 | 0.74 | 0.70 | 1.20 | 0.84 | 2 940 | 4 537 | 4 773 | 2 795 | 3 982 |
| **Indonesia** | 1.98 | 10.69 | 20.19 | 1.05 | 21.17 | 5 436 | 1 006 | 533 | 10 263 | 508 |
| **Ireland** | 1.13 | 3.16 | 3.44 | 1.04 | 3.57 | 3 434 | 1 228 | 1 127 | 3 739 | 1 086 |
| **Italy** | 1.90 | 5.59 | 9.73 | 1.09 | 10.63 | 6 123 | 2 081 | 1 196 | 10 653 | 1 095 |
| **Japan** | 1.31 | 4.97 | 6.20 | 1.05 | 6.51 | 3 595 | 947 | 759 | 4 483 | 723 |
| **Korea** | 1.24 | 6.14 | 7.39 | 1.03 | 7.63 | 4 379 | 887 | 737 | 5 271 | 713 |
| **Latvia** | 1.20 | 6.35 | 7.42 | 1.03 | 7.63 | 3 851 | 729 | 623 | 4 505 | 607 |
| **Liechtenstein** | 1.05 | 0.50 | 0.48 | 1.11 | 0.53 | 316 | 662 | 697 | 300 | 630 |
| **Luxembourg** | 1.36 | 0.64 | 0.51 | 1.70 | 0.87 | 2 890 | 6 121 | 7 654 | 2 311 | 4 509 |
| **Macao-China** | 1.29 | 1.01 | 1.01 | 1.28 | 1.30 | 970 | 1 236 | 1 233 | 973 | 960 |
| **Mexico** | 1.87 | 29.60 | 54.59 | 1.02 | 55.47 | 15 998 | 1 013 | 549 | 29 510 | 541 |
| **Netherlands** | 1.29 | 3.51 | 4.23 | 1.07 | 4.52 | 3 103 | 1 137 | 943 | 3 739 | 883 |
| **New Zealand** | 1.10 | 2.27 | 2.39 | 1.04 | 2.49 | 4 102 | 1 990 | 1 885 | 4 330 | 1 810 |
| **Norway** | 1.26 | 2.36 | 2.72 | 1.10 | 2.98 | 3 215 | 1 723 | 1 495 | 3 704 | 1 363 |
| **Poland** | 1.17 | 3.37 | 3.77 | 1.04 | 3.94 | 3 748 | 1 302 | 1 163 | 4 194 | 1 113 |
| **Portugal** | 1.11 | 6.75 | 7.36 | 1.01 | 7.46 | 4 166 | 683 | 626 | 4 543 | 617 |
| **Russian Federation** | 1.22 | 8.70 | 10.42 | 1.02 | 10.64 | 4 888 | 686 | 574 | 5 849 | 562 |
| **Serbia** | 1.11 | 7.59 | 8.30 | 1.01 | 8.41 | 3 977 | 580 | 530 | 4 349 | 524 |
| **Slovak Republic** | 1.03 | 8.10 | 8.33 | 1.00 | 8.37 | 7 111 | 907 | 882 | 7 317 | 878 |
| **Spain** | 1.83 | 4.38 | 7.19 | 1.12 | 8.02 | 5 898 | 2 463 | 1 502 | 9 674 | 1 346 |
| **Sweden** | 1.17 | 2.54 | 2.80 | 1.06 | 2.97 | 3 960 | 1 821 | 1 653 | 4 363 | 1 560 |
| **Switzerland** | 1.22 | 8.24 | 9.86 | 1.02 | 10.08 | 6 883 | 1 021 | 854 | 8 234 | 835 |
| **Thailand** | 1.70 | 3.97 | 6.06 | 1.12 | 6.76 | 3 073 | 1 320 | 865 | 4 691 | 775 |
| **Tunisia** | 1.48 | 2.74 | 3.58 | 1.14 | 4.06 | 3 181 | 1 726 | 1 320 | 4 158 | 1 163 |
| **Turkey** | 1.24 | 14.40 | 17.68 | 1.01 | 17.92 | 3 902 | 337 | 275 | 4 789 | 271 |
| **United Kingdom** | 1.47 | 4.46 | 6.09 | 1.08 | 6.56 | 6 489 | 2 137 | 1 567 | 8 852 | 1 455 |
| **United States** | 1.48 | 3.73 | 5.05 | 1.10 | 5.53 | 3 682 | 1 462 | 1 081 | 4 981 | 987 |
| **Uruguay** | 1.34 | 3.47 | 4.31 | 1.08 | 4.66 | 4 344 | 1 683 | 1 353 | 5 405 | 1 253 |



## Table 12.8 ■ Design effects and effective sample sizes for the mean performance on the scientific literacy scale

| | Design effect 1 | Design effect 2 | Design effect 3 | Design effect 4 | Design effect 5 | Effective sample size 1 | Effective sample size 2 | Effective sample size 3 | Effective sample size 4 | Effective sample size 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Australia** | 1.14 | 4.69 | 5.19 | 1.03 | 5.33 | 11 055 | 2 675 | 2 417 | 12 232 | 2 356 |
| **Austria** | 1.09 | 5.29 | 5.69 | 1.02 | 5.78 | 4 210 | 868 | 808 | 4 524 | 795 |
| **Belgium** | 1.47 | 3.18 | 4.20 | 1.11 | 4.67 | 5 987 | 2 767 | 2 093 | 7 912 | 1 883 |
| **Brazil** | 1.87 | 4.66 | 7.84 | 1.11 | 8.71 | 2 382 | 956 | 568 | 4 008 | 511 |
| **Canada** | 1.82 | 6.34 | 10.75 | 1.08 | 11.57 | 15 320 | 4 407 | 2 600 | 25 961 | 2 415 |
| **Czech Republic** | 1.58 | 4.52 | 6.55 | 1.09 | 7.12 | 4 006 | 1 400 | 965 | 5 808 | 887 |
| **Denmark** | 1.29 | 2.78 | 3.30 | 1.09 | 3.59 | 3 259 | 1 520 | 1 279 | 3 872 | 1 174 |
| **Finland** | 1.28 | 2.04 | 2.33 | 1.12 | 2.60 | 4 537 | 2 844 | 2 492 | 5 178 | 2 226 |
| **France** | 1.26 | 2.48 | 2.87 | 1.09 | 3.13 | 3 404 | 1 733 | 1 498 | 3 939 | 1 372 |
| **Germany** | 1.12 | 4.43 | 4.84 | 1.03 | 4.96 | 4 156 | 1 053 | 963 | 4 546 | 939 |
| **Greece** | 1.96 | 3.41 | 5.72 | 1.17 | 6.67 | 2 366 | 1 356 | 809 | 3 964 | 693 |
| **Hong Kong-China** | 1.19 | 7.74 | 8.99 | 1.02 | 9.18 | 3 777 | 578 | 498 | 4 387 | 488 |
| **Hungary** | 1.45 | 2.66 | 3.42 | 1.13 | 3.87 | 3 278 | 1 791 | 1 395 | 4 206 | 1 232 |
| **Iceland** | 1.05 | 0.75 | 0.74 | 1.07 | 0.79 | 3 179 | 4 469 | 4 551 | 3 122 | 4 240 |
| **Indonesia** | 1.70 | 14.11 | 23.26 | 1.03 | 23.95 | 6 340 | 762 | 463 | 10 448 | 449 |
| **Ireland** | 1.25 | 2.59 | 2.99 | 1.08 | 3.25 | 3 096 | 1 497 | 1 296 | 3 578 | 1 195 |
| **Italy** | 1.20 | 8.14 | 9.59 | 1.02 | 9.80 | 9 668 | 1 430 | 1 213 | 11 397 | 1 188 |
| **Japan** | 1.10 | 6.16 | 6.65 | 1.01 | 6.75 | 4 296 | 764 | 707 | 4 640 | 697 |
| **Korea** | 1.11 | 6.07 | 6.64 | 1.02 | 6.75 | 4 898 | 897 | 820 | 5 354 | 807 |
| **Latvia** | 1.15 | 7.08 | 7.99 | 1.02 | 8.14 | 4 026 | 654 | 579 | 4 542 | 569 |
| **Liechtenstein** | 1.16 | 0.50 | 0.42 | 1.39 | 0.58 | 285 | 665 | 795 | 238 | 571 |
| **Luxembourg** | 1.25 | 0.67 | 0.58 | 1.43 | 0.83 | 3 135 | 5 889 | 6 738 | 2 740 | 4 706 |
| **Macao-China** | 1.19 | 1.25 | 1.30 | 1.14 | 1.49 | 1 053 | 998 | 962 | 1 093 | 841 |
| **Mexico** | 5.90 | 8.22 | 43.61 | 1.11 | 48.51 | 5 078 | 3 649 | 688 | 26 952 | 618 |
| **Netherlands** | 1.29 | 3.15 | 3.78 | 1.08 | 4.07 | 3 093 | 1 267 | 1 057 | 3 707 | 981 |
| **New Zealand** | 1.16 | 2.00 | 2.15 | 1.07 | 2.31 | 3 891 | 2 261 | 2 094 | 4 201 | 1 950 |
| **Norway** | 1.14 | 2.73 | 2.97 | 1.05 | 3.11 | 3 570 | 1 487 | 1 367 | 3 883 | 1 306 |
| **Poland** | 1.04 | 3.30 | 3.39 | 1.01 | 3.43 | 4 222 | 1 328 | 1 293 | 4 334 | 1 279 |
| **Portugal** | 1.14 | 5.56 | 6.19 | 1.02 | 6.33 | 4 052 | 828 | 745 | 4 508 | 728 |
| **Russian Federation** | 1.15 | 8.92 | 10.14 | 1.02 | 10.29 | 5 178 | 670 | 589 | 5 885 | 580 |
| **Serbia** | 1.36 | 5.80 | 7.52 | 1.05 | 7.88 | 3 246 | 759 | 586 | 4 205 | 559 |
| **Slovak Republic** | 1.02 | 9.47 | 9.66 | 1.00 | 9.68 | 7 183 | 776 | 760 | 7 329 | 759 |
| **Spain** | 1.38 | 5.31 | 6.96 | 1.05 | 7.34 | 7 806 | 2 032 | 1 550 | 10 229 | 1 470 |
| **Sweden** | 1.43 | 2.11 | 2.59 | 1.17 | 3.01 | 3 240 | 2 191 | 1 789 | 3 968 | 1 535 |
| **Switzerland** | 1.20 | 8.26 | 9.69 | 1.02 | 9.89 | 7 033 | 1 019 | 869 | 8 252 | 851 |
| **Thailand** | 1.33 | 4.34 | 5.45 | 1.06 | 5.78 | 3 934 | 1 205 | 960 | 4 936 | 905 |
| **Tunisia** | 1.10 | 3.68 | 3.96 | 1.03 | 4.06 | 4 284 | 1 282 | 1 193 | 4 602 | 1 163 |
| **Turkey** | 1.26 | 14.56 | 18.04 | 1.01 | 18.29 | 3 864 | 333 | 269 | 4 787 | 265 |
| **United Kingdom** | 1.20 | 4.81 | 5.56 | 1.04 | 5.76 | 7 964 | 1 983 | 1 715 | 9 208 | 1 656 |
| **United States** | 1.32 | 3.80 | 4.69 | 1.07 | 5.01 | 4 139 | 1 437 | 1 164 | 5 109 | 1 090 |
| **Uruguay** | 1.04 | 3.95 | 4.07 | 1.01 | 4.11 | 5 608 | 1 478 | 1 435 | 5 778 | 1 421 |

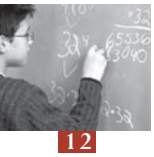




Table 12.9 ■ **Design effects and effective sample sizes for the percentage of students at Level 3 on the mathematical literacy scale**

| | Design effect 1 | Design effect 2 | Design effect 3 | Design effect 4 | Design effect 5 | Effective sample size 1 | Effective sample size 2 | Effective sample size 3 | Effective sample size 4 | Effective sample size 5 |
|---|---|---|---|---|---|---|---|---|---|---|
| **Australia** | 2.51 | 1.39 | 1.99 | 1.76 | 3.49 | 5 005 | 9 010 | 6 321 | 7 134 | 3 593 |
| **Austria** | 2.44 | 1.32 | 1.78 | 1.81 | 3.22 | 1 882 | 3 487 | 2 586 | 2 537 | 1 428 |
| **Belgium** | 2.00 | 1.39 | 1.78 | 1.56 | 2.78 | 4 406 | 6 319 | 4 935 | 5 643 | 3 166 |
| **Brazil** | 1.24 | 3.40 | 3.98 | 1.06 | 4.22 | 3 581 | 1 311 | 1 119 | 4 195 | 1 055 |
| **Canada** | 4.18 | 1.55 | 3.29 | 1.97 | 6.47 | 6 686 | 18 074 | 8 509 | 14 202 | 4 323 |
| **Czech Republic** | 1.24 | 2.48 | 2.84 | 1.08 | 3.08 | 5 107 | 2 543 | 2 227 | 5 832 | 2 055 |
| **Denmark** | 1.58 | 1.07 | 1.10 | 1.52 | 1.68 | 2 674 | 3 956 | 3 818 | 2 770 | 2 507 |
| **Finland** | 1.15 | 1.07 | 1.08 | 1.14 | 1.23 | 5 053 | 5 398 | 5 344 | 5 104 | 4 706 |
| **France** | 1.25 | 1.76 | 1.95 | 1.13 | 2.21 | 3 431 | 2 442 | 2 201 | 3 806 | 1 948 |
| **Germany** | 1.49 | 1.21 | 1.32 | 1.37 | 1.81 | 3 119 | 3 841 | 3 534 | 3 390 | 2 571 |
| **Greece** | 1.73 | 1.68 | 2.18 | 1.34 | 2.91 | 2 672 | 2 749 | 2 120 | 3 465 | 1 588 |
| **Hong Kong-China** | 3.44 | 1.27 | 1.92 | 2.28 | 4.36 | 1 301 | 3 538 | 2 338 | 1 968 | 1 028 |
| **Hungary** | 1.55 | 1.43 | 1.67 | 1.33 | 2.22 | 3 082 | 3 324 | 2 853 | 3 591 | 2 150 |
| **Iceland** | 1.39 | 0.97 | 0.96 | 1.40 | 1.35 | 2 418 | 3 444 | 3 482 | 2 392 | 2 486 |
| **Indonesia** | 1.88 | 5.63 | 9.69 | 1.09 | 10.57 | 5 729 | 1 912 | 1 110 | 9 867 | 1 018 |
| **Ireland** | 1.02 | 1.28 | 1.28 | 1.01 | 1.30 | 3 810 | 3 042 | 3 030 | 3 825 | 2 987 |
| **Italy** | 1.26 | 3.67 | 4.36 | 1.06 | 4.62 | 9 231 | 3 174 | 2 667 | 10 982 | 2 517 |
| **Japan** | 1.65 | 1.72 | 2.19 | 1.30 | 2.84 | 2 854 | 2 732 | 2 147 | 3 631 | 1 656 |
| **Korea** | 1.67 | 1.70 | 2.17 | 1.31 | 2.84 | 3 260 | 3 199 | 2 507 | 4 161 | 1 916 |
| **Latvia** | 2.29 | 1.38 | 1.88 | 1.69 | 3.17 | 2 021 | 3 345 | 2 464 | 2 743 | 1 461 |
| **Liechtenstein** | 1.21 | 1.05 | 1.06 | 1.20 | 1.27 | 275 | 316 | 313 | 277 | 261 |
| **Luxembourg** | 1.50 | 0.85 | 0.77 | 1.65 | 1.27 | 2 617 | 4 640 | 5 106 | 2 378 | 3 095 |
| **Macao-China** | 1.41 | 1.41 | 1.58 | 1.26 | 1.99 | 888 | 886 | 792 | 994 | 629 |
| **Mexico** | 3.31 | 7.00 | 20.87 | 1.11 | 23.17 | 9 062 | 4 281 | 1 437 | 26 996 | 1 294 |
| **Netherlands** | 1.55 | 1.88 | 2.36 | 1.23 | 2.91 | 2 582 | 2 123 | 1 691 | 3 242 | 1 373 |
| **New Zealand** | 1.99 | 1.03 | 1.07 | 1.92 | 2.06 | 2 269 | 4 360 | 4 220 | 2 344 | 2 193 |
| **Norway** | 2.00 | 1.10 | 1.21 | 1.83 | 2.20 | 2 035 | 3 684 | 3 370 | 2 224 | 1 845 |
| **Poland** | 1.71 | 1.19 | 1.33 | 1.53 | 2.04 | 2 564 | 3 680 | 3 304 | 2 856 | 2 153 |
| **Portugal** | 1.48 | 1.83 | 2.22 | 1.22 | 2.70 | 3 117 | 2 522 | 2 073 | 3 792 | 1 706 |
| **Russian Federation** | 1.56 | 2.24 | 2.94 | 1.19 | 3.50 | 3 818 | 2 669 | 2 034 | 5 011 | 1 706 |
| **Serbia** | 1.74 | 2.05 | 2.83 | 1.26 | 3.58 | 2 526 | 2 147 | 1 555 | 3 489 | 1 231 |
| **Slovak Republic** | 2.91 | 1.57 | 2.66 | 1.72 | 4.57 | 2 523 | 4 677 | 2 760 | 4 275 | 1 606 |
| **Spain** | 4.26 | 1.36 | 2.52 | 2.29 | 5.78 | 2 535 | 7 946 | 4 276 | 4 711 | 1 867 |
| **Sweden** | 2.01 | 1.09 | 1.18 | 1.85 | 2.19 | 2 306 | 4 234 | 3 903 | 2 501 | 2 111 |
| **Switzerland** | 1.36 | 3.25 | 4.05 | 1.09 | 4.41 | 6 204 | 2 591 | 2 077 | 7 738 | 1 909 |
| **Thailand** | 1.49 | 2.15 | 2.70 | 1.18 | 3.19 | 3 518 | 2 441 | 1 936 | 4 435 | 1 640 |
| **Tunisia** | 1.38 | 2.37 | 2.89 | 1.13 | 3.27 | 3 431 | 1 988 | 1 633 | 4 178 | 1 445 |
| **Turkey** | 2.10 | 3.19 | 5.59 | 1.20 | 6.68 | 2 316 | 1 523 | 869 | 4 059 | 726 |
| **United Kingdom** | 2.77 | 1.41 | 2.15 | 1.82 | 3.92 | 3 440 | 6 739 | 4 435 | 5 227 | 2 431 |
| **United States** | 1.48 | 1.29 | 1.43 | 1.33 | 1.90 | 3 696 | 4 232 | 3 824 | 4 091 | 2 867 |
| **Uruguay** | 1.13 | 1.71 | 1.80 | 1.07 | 1.93 | 5 157 | 3 413 | 3 236 | 5 438 | 3 016 |



### *Notes*

1 The Italy and Spain entries are more than the sum of the listed parts since not all parts were required to be broken out.

2 Sweden's enrolled population is larger than the number of 15 year olds because it is based on estimated data from a different source.

3 The Netherlands' frame count of ENR was 196 908 because of rounding decimal values of ENR and imputing values of 1 when ENR was zero or missing.

4 Tunisia noted late in the process that one French school (121726) needed to be excluded because of French (rather than Arabic) language – it had 33 eligible students. This is reflected in the 3[b] number.

5 Indonesia excluded four provinces and close to 5 per cent of its eligible population due to security reasons. There were 4 137 103 15-years old for 2[a], but the four provinces were already excluded. Therefore, the 144 792 noted as being excluded in these provinces was added to this number to get 4 281 895 15-year-olds. The number of enrolled 15-year-olds was noted as 2968756 so 144 792 was also added to this. Then, the 14 4792 was taken off to arrive at the 3[a] number.

6 Serbia excluded Kosovo and there were no estimates for the number of 15-year-olds so this does not appear as an exclusion.

7 Greece originally had excluded students in primary schools but since the population was later changed to 15-year-olds in grades 7 and above, the population figures have been adjusted so that these are not exclusions, but not part of the population to begin with.

8 Portugal's enrolled number of 15-year-olds is likely an underestimate because this number came from schools that responded to questions about the number of 15-year-olds. There were non-respondents.

9 Canada's Sf2[b] is greater than the Sf3[a] number due to different data sources.

10 The Russian Federation's PSU frame is from 1999 statistics and had a frame count of 1 772 900 students, which likely underestimates the PISA 2003 population of 15-year-olds. Also, the school-level frame count was 1 422 600, which also likely underestimates the population over selected PSUs given an SF3[c] of 1 847 166 for the sampled regions only.

11 The Czech Republic's exclusion code 4 was for students abroad or absent for long periods. These students additionally had a SEN code for reading disorders.

12 Finland's exclusion code 4 was defined as dyslexia (after the fact).

13 Greece's exclusion code 4 was defined as dyslexia.

14 Denmark's exclusion code 4 was for dyslexia/acalculia.

15 Germany had six students excluded after the fact with code=4 after they were given the UH booklet in a school where not all students were given the UH booklet.

16 Luxembourg's exclusion code 4 was for students being "primo-arrivants". This code applies to students who have only very recently come to Luxembourg, normally as asylum-seekers.

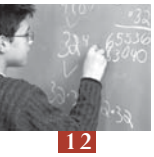
17 Ireland's exclusion code 4 was for dyslexia.

18 Poland's exclusion code 4 was for dyslexia.

19 Spain's sampling form numbers were updated from census figures for 2003.

20 Serbia originally had 724 for school-level exclusions. After weighting, it was realised that primary schools, although thought to be on the frame, were not. Thus, 3065 has been added to school-level exclusions.

21 To arrive at the adjusted column for SF2[b] with 15-year olds in grades 5 and 6 removed, one of 4 sources of country data were used for each country. For Australia, Brazil, Macao-China, Mexico, Thailand, Tunisia and Uruguay, sampling was done after the population definition so sampling forms numbers did not include counts for students in grades 5 and 6. Poland had these students as part of their school level exclusions-- they were removed from exclusions and used to arrive at the adjusted figure for SF2[b]. For Denmark, Germany, Italy, Latvia, Russia, Slovakia and Turkey, estimates from the sample were removed from the column for within-school student level exclusions for this reason, and used to adjust the original





SF2[b]. All other countries supplied estimates for adjusting SF2[b], except for Iceland and Luxembourg which did not supply any information so 0 in these grades has been assumed.

22 Canada did not have any ineligible students in grades 5 and 6. However they had excluded home school students under exclusion category 4, when really these students are being classed in other countries as ineligible. Thus these have been moved to ineligible grade 5/6 for Canada. Sampling form numbers have also been adjusted to remove the 66 students originally excluded from home schools. This was similarly done for the US (17 students and 8536 weighted).

23 Mexico could not conduct an assessment in the province of Michoacan (stratum 16) because of a teacher strike so all students in these schools have been regarded as exclusions at the school-level (46472 based on SF8).



# READER'S GUIDE

## Country codes

The following country codes are used in this report:

*OECD countries*

**AUS** Australia
**AUT** Austria
**BEL** Belgium
**BEF** Belgium (French Community)
**BEN** Belgium (Flemish Community)
**CAN** Canada
**CAE** Canada (English Community)
**CAF** Canada (French Community)
**CZE** Czech Republic
**DNK** Denmark
**FIN** Finland
**FRA** France
**DEU** Germany
**GRC** Greece
**HUN** Hungary
**ISL** Iceland
**IRL** Ireland
**ITA** Italy
**JPN** Japan
**KOR** Korea
**LUX** Luxembourg
**LXF** Luxembourg (French Community)
**LXG** Luxembourg (German Community)
**MEX** Mexico
**NLD** Netherlands
**NZL** New Zealand
**NOR** Norway
**POL** Poland
**PRT** Portugal
**SVK** Slovak Republic
**ESP** Spain
**ESB** Spain (Basque Community)
**ESC** Spain (Catalonian Community)
**ESS** Spain (Castillian Community)
**SWE** Sweden
**CHE** Switzerland
**CHF** Switzerland (French Community)
**CHG** Switzerland (German Community)
**CHI** Switzerland (Italian Community)
**TUR** Turkey
**GBR** United Kingdom
**IRL** Ireland
**SCO** Scotland
**USA** United States

*Partner countries*

**BRA** Brazil
**HKG** Hong Kong-China
**IND** Indonesia
**LVA** Latvia
**LVL** Latvia (Latvian Community)
**LVR** Latvia (Russian Community)
**LIE** Liechtenstein
**MAC** Macao-China
**RUS** Russian Federation
**YUG** Serbia and Montenegro (Serbia)
**THA** Thailand
**TUN** Tunisia
**URY** Uruguay



### List of abbreviations

The following abbreviations are used in this report:

| | |
|---|---|
| **ACER** | Australian Council for Educational Research |
| **AGFI** | Adjusted Goodness-of-Fit Index |
| **BRR** | Balanced Repeated Replication |
| **CFA** | Confirmatory Factor Analysis |
| **CFI** | Comparative Fit Index |
| **CITO** | National Institute for Educational Measurement, The Netherlands |
| **CIVED** | Civic Education Study |
| **DIF** | Differential Item Functioning |
| **ESCS** | Economic, Social and Cultural Status |
| **ENR** | Enrolment of 15-year-olds |
| **ETS** | Educational Testing Service |
| **IAEP** | International Assessment of Educational Progress |
| **I** | Sampling Interval |
| **ICR** | Inter-Country Coder Reliability Study |
| **ICT** | Information Communication Technology |
| **IEA** | International Association for the Evaluation of Educational Achievement |
| **INES** | OECD Indicators of Education Systems |
| **IRT** | Item Response Theory |
| **ISCED** | International Standard Classification of Education |
| **ISCO** | International Standard Classification of Occupations |
| **ISEI** | International Socio-Economic Index |
| **MENR** | Enrolment for moderately small school |
| **MOS** | Measure of size |
| **NCQM** | National Centre Quality Monitor |
| **NDP** | National Desired Population |
| **NEP** | National Enrolled Population |
| **NFI** | Normed Fit Index |
| **NIER** | National Institute for Educational Research, Japan |
| **NNFI** | Non-Normed Fit Index |
| **NPM** | National Project Manager |
| **OECD** | Organisation for Economic Cooperation and Development |
| **PISA** | Programme for International Student Assessment |
| **PPS** | Probability Proportional to Size |
| **PGB** | PISA Governing Board |
| **PQM** | PISA Quality Monitor |
| **PSU** | Primary Sampling Units |
| **QAS** | Questionnaire Adaptations Spreadsheet |
| **RMSEA** | Root Mean Square Error of Approximation |
| **RN** | Random Number |
| **SC** | School Co-ordinator |
| **SD** | Standard Deviation |
| **SEM** | Structural Equation Modelling |
| **SMEG** | Subject Matter Expert Group |
| **SPT** | Study Programme Table |
| **TA** | Test Administrator |
| **TAG** | Technical Advisory Group |
| **TCS** | Target Cluster Size |
| **TIMSS** | Third International Mathematics and Science Study |
| **TIMSS-R** | Third International Mathematics and Science Study – Repeat |
| **VENR** | Enrolment for very small schools |
| **WLE** | Weighted Likelihood Estimates |



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