4

Sample Design

Target population and overview of the sampling design 66

Main Survey school sample.. 70

TARGET POPULATION AND OVERVIEW OF THE SAMPLING DESIGN

The international PISA target population in each participating country and economy consisted of 15-year-old students attending educational institutions in grade 7 and higher. This meant that countries were to include 15-year-old students:

- enrolled full-time in educational institutions;
- enrolled in educational institutions who attended only on a part-time basis;
- enrolled in vocational training programmes, or any other related type of educational programmes; and
- attending foreign schools within the country (as well as students from other countries attending any of the programmes in the first three categories).

It was recognised that no testing of 15-year-olds schooled full-time in the home, workplace or out of the country would occur and therefore these 15-year-olds were not included in the international target population.

The operational definition of an age population directly depends on the testing dates. The international requirement was that the assessment had to be conducted during a 42-day period, referred to as the testing period, between 1 March 2012 and 31 August 2012, unless otherwise agreed.

Further, testing was not permitted during the first six weeks of the school year because of a concern that student performance levels may have been lower at the beginning of the academic year than at the end of the previous academic year, even after controlling for age.

The 15-year-old international target population was slightly adapted to better fit the age structure of most of the Northern Hemisphere countries. As the majority of the testing was planned to occur in April, the international target population was consequently defined as all students aged from 15 years and 3 completed months to 16 years and 2 completed months at the beginning of the assessment period. This meant that in all countries testing in April 2012, the target population could have been defined as all students born in 1996 who were attending an educational institution as defined above.

A variation of up to one month in this age definition was permitted. This allowed a country testing in March or in May to still define the national target population as all students born in 1996. If the testing was to take place at another time until the end of August, the birth date definition had to be adjusted so that in all countries the target population was always students aged 15 years and 3 completed months to 16 years and 2 completed months at the time of testing, or a one month variation of this.

In all but one country, the Russian Federation, the sampling design used for the PISA assessment was a two-stage stratified sample design. The first-stage sampling units consisted of individual schools having 15-year-old students. Schools were sampled systematically from a comprehensive national list of all PISA-eligible schools, known as the school sampling frame, with probabilities that were proportional to a measure of size. The measure of size was a function of the estimated number of PISA-eligible 15-year-old students enrolled in the school. This is referred to as systematic Probability Proportional to Size (PPS) sampling. Prior to sampling, schools in the sampling frame were assigned to mutually exclusive groups based on school characteristics called explicit strata, formed in particular to improve the precision of sample-based estimates.

The second-stage sampling units in countries using the two-stage design were students within sampled schools. Once schools were selected to be in the sample, a complete list of each sampled school's 15-year-old students was prepared. For each country a Target Cluster Size *(TCS)* was set, this value was typically 35 students although with agreement countries could use alternative values. From each list of students that contained more than the *TCS*, a sample of typically 35 students were selected with equal probability and for lists of fewer than the *TCS*, all students on the list were selected.

For countries participating in the international option of Financial Literacy (FL), the *TCS* was increased in each sampled school so as to also achieve the required student sample size for FL.

In the Russian Federation, a three-stage design was used. In this case, geographical areas were sampled first (first-stage units) using PPS sampling, and then schools (second-stage units) were selected within these sampled geographical areas. Students were the third-stage sampling units in this three-stage design and were sampled from the selected schools.

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Population coverage, and school and student participation rate standards

To provide valid estimates of student achievement, the sample of students had to be selected using established and professionally recognised principles of scientific sampling, in a way that ensured representation of the full target population of 15-year-old students in the participating countries.

Furthermore, quality standards had to be maintained with respect to: *(i)* the coverage of the PISA international target population; *(ii)* accuracy and precision; and *(iii)* the school and student response rates.

Coverage of the PISA international target population

National Project Managers (NPMs) might have found it necessary to reduce their coverage of the target population by excluding, for instance, a small, remote geographical region due to inaccessibility, or a language group, possibly due to political, organisational or operational reasons, or special education needs students. In an international survey in education, the types of exclusion must be defined consistently for all participating countries and the exclusion rates have to be limited. Indeed, if a significant proportion of students were excluded, this would mean that survey results would not be deemed representative of the entire national school system. Thus, efforts were made to ensure that exclusions, if they were necessary, were minimised according to the PISA 2012 Technical Standards (see Annex F).

Exclusion can take place at the school level (exclusion of entire schools) or at the within-school level (exclusion of individual students). Areas deemed to be part of a country (for the purpose of PISA), but which were not included for sampling, although this occurred infrequently, were designated as non-covered areas. Care was taken in this regard because, when such situations did occur, the national desired target population differed from the international desired target population.

International within-school exclusion rules for students were specified as follows:

- Intellectually disabled students are students who have a mental or emotional disability and who, in the professional opinion of qualified staff, are cognitively delayed such that they cannot be validly assessed in the PISA testing setting. This category includes students who are emotionally or mentally unable to follow even the general instructions of the test. Students were not to be excluded solely because of poor academic performance or normal discipline problems.
- Functionally disabled students are students who are permanently physically disabled in such a way that they cannot be validly assessed in the PISA testing setting. Functionally disabled students who could provide responses were to be included in the testing.
- Students with insufficient assessment language experience are students who need to meet all of the following criteria: *i)* are not native speakers of the assessment language(s); *ii)* have limited proficiency in the assessment language(s); and *iii)* have received less than one year of instruction in the assessment language(s). Students with insufficient assessment language experience could be excluded.
- Students not assessable for other reasons as agreed upon. A nationally-defined within-school exclusion category was permitted if agreed upon by the PISA Consortium. A specific sub-group of students (for example students with dyslexia, dysgraphia, or dyscalculia) could be identified for whom exclusion was necessary but for whom the previous three within-school exclusion categories did not explicitly apply, so that a more specific within-school exclusion definition was needed.
- Students whose language of instruction for mathematics (the major domain for 2012), was one for which no PISA assessment materials were available. Standard 2.1 of the PISA 2012 Technical Standards (see Annex F) notes that the PISA test is administered to a student in a language of instruction provided by the sampled school to that sampled student in the major domain of the test. Thus, if no test materials were available in the language in which the sampled student is taught, the student was excluded.

A school attended only by students who would be excluded for intellectual, functional or linguistic reasons was considered a school-level exclusion.

It was required that the overall exclusion rate within a country (i.e. school-level and within-school exclusions combined) be kept below 5% of the PISA desired target population. Guidelines for restrictions on the level of exclusions of various types were as follows:

- School-level exclusions for inaccessibility, feasibility, or reasons other than those described in the next points were to cover less than 0.5% of the total number of students in the international target population for participating countries. Schools on the school sampling frame which had only one or two PISA-eligible students were not allowed to be

excluded from the frame. However, if, based on the frame, it was clear that the percentage of students in these small schools would not cause a breach of the 0.5% allowable limit, then such schools could be excluded in the field at that time of the assessment, if they still only had one or two PISA-eligible students.

- School-level exclusions for intellectually or functionally disabled students, or students with insufficient assessment language experience, were to cover fewer than 2% of students.
- Because definitions of within-school exclusions could vary from country to country, NPMs were asked to adapt the international definitions to make them workable in their country but still to code them according to the PISA international coding scheme. Within-school exclusions for intellectually disabled or functionally disabled students, or students with insufficient assessment language experience, or students nationally-defined and agreed upon for exclusion were expected to cover fewer than 2.5% of students. Initially, this could only be an estimate. If the actual percentage was ultimately greater than 2.5%, the percentage was re-calculated without considering students excluded because of insufficient assessment language experience since this is known to be a largely unpredictable part of each country's PISA-eligible population, not under the control of the education system. If the resulting percentage was below 2.5%, the exclusions were regarded as acceptable.

Accuracy and precision

A minimum of 150 schools had to be selected in each country; if a participating country had fewer than 150 schools then all schools were selected. Within each participating school, a predetermined number of students, denoted as *TCS* (usually 35 students), were randomly selected with equal probability, or in schools with fewer than *TCS* eligible students, all students were selected. In total, a minimum sample size of 4 500 assessed students was to be achieved, or the full population if it was less than this size. It was possible to negotiate a *TCS* that differed from 35 students, but if it was reduced then the sample size of schools was increased beyond 150, so as to ensure that at least 4 500 students would be assessed. The *TCS* selected per school had to be at least 20 students, so as to ensure adequate accuracy in estimating variance components within and between schools – a major analytical objective of PISA.

NPMs were strongly encouraged to identify available variables to use for defining the explicit and implicit strata for schools to reduce the sampling variance. See later section on stratification for other benefits.

For countries which had participated in previous PISA assessments that had larger than anticipated sampling variances associated with their estimates, recommendations were made about sample design changes that would possibly help to reduce the sampling variances for PISA 2012. These included modifications to stratification variables, and increases in the required sample size.

School response rates

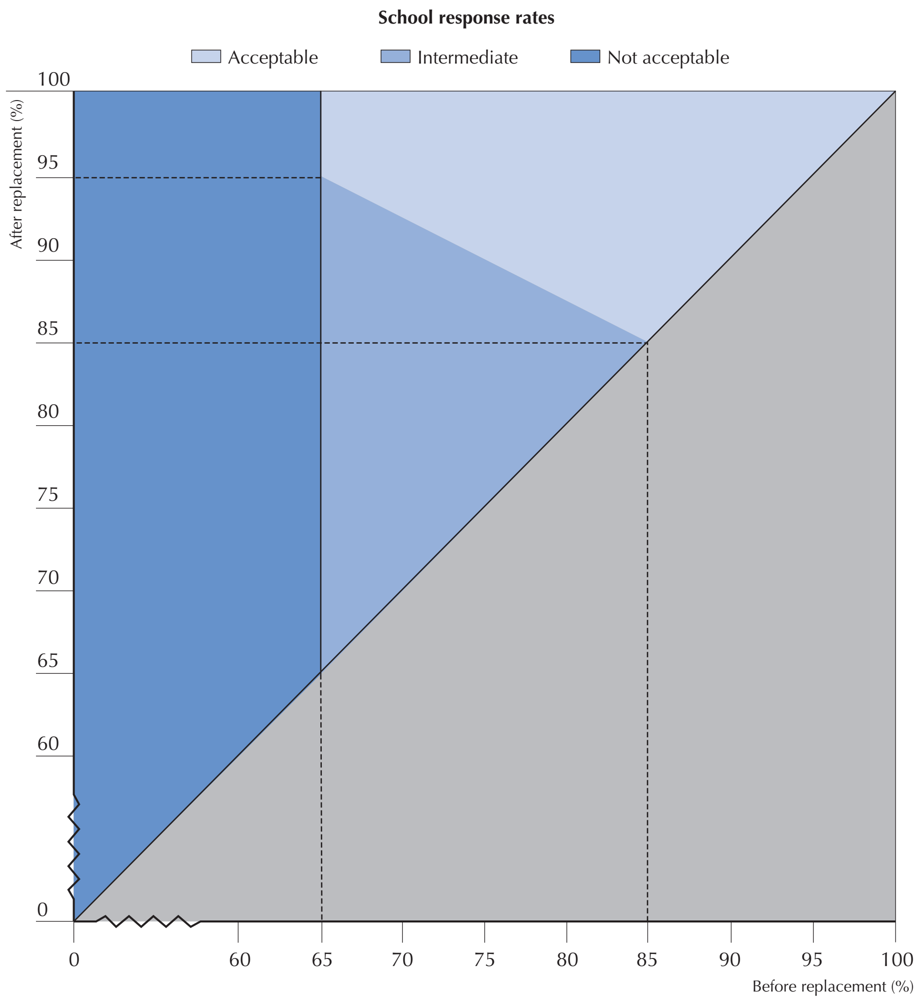
A response rate of 85% was required for initially selected schools. If the initial school response rate fell between 65% and 85%, an acceptable school response rate could still be achieved through the use of replacement schools. Figure 4.1 provides a summary of the international requirements for school response rates. To compensate for a sampled school that did not participate, where possible, two potential replacement schools were identified. Furthermore, a school with a student participation rate between 25% and 50% was not considered as a participating school for the purposes of calculating and documenting response rates.[1] However, data from such schools were included in the database and contributed to the estimates included in the initial PISA international report. Data from schools with a student participation rate of less than 25% were not included in the database, and such schools were regarded as non-respondents.

The rationale for this approach was as follows. There was concern that, in an effort to meet the requirements for school response rates, a National Centre might accept participation from schools that would not make a concerted effort to have students attend the assessment sessions. To avoid this, a standard for student participation was required for each individual school in order that the school be regarded as a participant. This standard was set at a minimum of 50% student participation. However, there were a few schools in many countries that conducted the assessment without meeting that standard. Thus a judgement was needed to decide if the data from students in such schools should be used in the analyses, given that the students had already been assessed. If the students from such schools were retained, non-response bias would possibly be introduced to the extent that the students who were absent could have been different in achievement from those who attended the testing session, and such a bias is magnified by the relative sizes of these two groups. If one chose to delete all assessment data from such schools, then non-response bias would be introduced to the extent that the school was different from others in the sample, and sampling variance would be increased because of sample size attrition.

The judgement was made that, for a school with between 25% and 50% student response, the latter source of bias and variance was likely to introduce more error into the study estimates than the former, but with the converse judgement for those schools with a student response rate below 25%. Clearly the cut-off of 25% is arbitrary as one would need extensive studies to try to establish this cut-off empirically. However, it is clear that, as the student response rate decreases within a school, the possibility of bias from using the assessed students in that school will increase, while the loss in sample size from dropping all of the students in the school will be small.

■ Figure 4.1 ■

School response rate standards



These PISA standards applied to weighted school response rates. The procedures for calculating weighted response rates are presented in Chapter 11. Weighted response rates weigh each school by the number of students in the population that are represented by the students sampled from within that school. The weight consists primarily of the enrolment size of 15-year-old students in the school, divided by the selection probability of the school. Because the school samples were selected with PPS, in most countries many schools contributed equal weights, and as a consequence the weighted and unweighted school response rates were similar. Exceptions could occur in countries that had explicit strata that were sampled at very different rates.

Student response rates

An overall weighted response rate of 80% of selected students in participating schools was required. A student who had participated in the original or follow-up cognitive sessions was considered to be a participant. A minimum student response rate of 50% within each school was required for a school to be regarded as participating: the overall student

response rate was computed using only students from schools with at least a 50% student response rate. Again, weighted student response rates were used for assessing this standard. Each student was weighted by the reciprocal of his/her sample selection probability.

MAIN SURVEY SCHOOL SAMPLE

Definition of the national target population

NPMs were first required to confirm their dates of testing and age definition with the PISA Consortium. NPMs were warned to avoid having any possible drift in the assessment period lead to an unapproved definition of the national target population.

Every NPM was required to define and describe their country's target population and explain how and why it might deviate from the international target population. Any hardships in accomplishing complete coverage were specified, discussed and approved or not, in advance. Where the national target population deviated from full coverage of all PISA-eligible students, the deviations were described and enrolment data provided to measure the degree to which coverage was reduced. The population, after all exclusions, corresponded to the population of students recorded on each country's school sampling frame. Exclusions were often proposed for practical reasons such as increased survey costs or complexity in the sample design and/or difficult test conditions. These difficulties were mainly addressed by modifying the sample design to reduce the number of such schools selected rather than to exclude them. Schools with students that would all be excluded through the within-school exclusion categories could be excluded up to a maximum of 2% as previously noted. Otherwise, countries were instructed to include the schools but to administer the PISA UH (une heure) booklet (see Chapter 2 for more details on the UH booklet), consisting of a subset of the PISA assessment items, deemed more suitable for students with special education needs. Eleven countries used the UH booklet for PISA 2012.

Within participating schools, all PISA-eligible students (i.e., born within the defined time period and in Grade 7 or higher) were to be listed. From this, either a sample of students equal in size to the *TCS* was randomly selected or all students were selected if there were fewer students than the *TCS*. The lists had to include students deemed to meet any of the categories for exclusion, and a variable maintained to briefly describe the reason for exclusion. This made it possible to estimate the size of the within-school exclusions from the sample data.

It was understood that the exact extent of within-school exclusions would not be known until the within-school sampling data were returned from participating schools, and sampling weights computed. Participating country projections for within-school exclusions provided before school sampling were known to be estimates.

NPMs were made aware of the distinction between within-school exclusions and nonresponse. Students who could not take the PISA achievement tests because of a permanent condition were to be excluded and those with a temporary impairment at the time of testing, such as a broken arm, were treated as non-respondents along with other sampled students who were absent.

Exclusions by country are documented in Chapter 11.

The sampling frame

All NPMs were required to construct a school sampling frame to correspond to their national defined target population. The school sampling frame was defined in the *School Sampling Preparation Manual*[2] as a frame that would provide complete coverage of the national defined target population without being contaminated by incorrect or duplicate entries or entries referring to elements that were not part of the defined target population. It was expected that the school sampling frame would include any school that could have 15-year-old students, even those schools which might later be excluded, or deemed ineligible because they had no PISA-eligible students at the time of data collection. The quality of the sampling frame directly affects the survey results through the schools' probabilities of selection and therefore their weights and the final survey estimates. NPMs were therefore advised to be diligent and thorough in constructing their school sampling frames.

All but one country used school-level sampling frames as their first stage of sample selection. The *School Sampling Preparation Manual* indicated that the quality of sampling frames for both two- and three-stage designs would largely depend on the accuracy of the approximate enrolment of 15-year-olds available (*ENR*) for each first-stage sampling unit.

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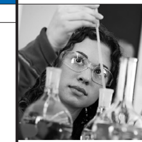


A suitable *ENR* value was a critical component of the sampling frames since selection probabilities were based on it for both two- and three-stage designs. The best *ENR* for PISA was the number of currently enrolled 15-year-old students. Current enrolment data, however, were rarely available at the time of school sampling, which meant using alternatives. Most countries used the first-listed available option from the following list of alternatives:

- student enrolment in the target age category (15-year-olds) from the most recent year of data available;
- if 15-year-olds tend to be enrolled in two or more grades, and the proportions of students who are aged 15 in each grade are approximately known, the 15-year-old enrolment can be estimated by applying these proportions to the corresponding grade-level enrolments;
- the grade enrolment of the modal grade for 15-year-olds; and
- total student enrolment, divided by the number of grades in the school.

The *School Sampling Preparation Manual* noted that if reasonable estimates of *ENR* did not exist or if the available enrolment data were out of date, schools might have to be selected with equal probabilities which might require an increased school sample size. However, no countries needed to use this option.

Besides *ENR* values, NPMs were instructed that each school entry on the frame should include at minimum:

- school identification information, such as a unique numerical national identification, and contact information such as name, address and phone number; and
- coded information about the school, such as region of country, school type and extent of urbanisation, which could possibly be used as stratification variables.

As noted, a three-stage design and an area-level (geographic) sampling frame could be used where a comprehensive national list of schools was not available and could not be constructed without undue burden, or where the procedures for administering the test required that the schools be selected in geographic clusters. As a consequence, the area-level sampling frame introduced an additional stage of frame creation and sampling (first stage) before actually sampling schools (second stage with the third stage being students). Although generalities about three-stage sampling and using an area-level sampling frame were outlined in the *School Sampling Preparation Manual* (for example that there should be at least 80 first-stage units and at least 40 needed to be sampled), NPMs were also informed that the more detailed procedures outlined there for the general two-stage design could easily be adapted to the three-stage design. The NPM using a three-stage design was also asked to notify the PISA Consortium and received additional support in constructing and using an area-level sampling frame. The only country that used a three-stage design was the Russian Federation, where a national list of schools was not available. The use of the three-stage design allowed for school lists to be obtained only for those areas selected in stage one rather than for the entire country.

Stratification

Prior to sampling, schools were to be ordered, or stratified, in the sampling frame. Stratification consists of classifying schools into *like* groups according to selected variables referred to as stratification variables. Stratification in PISA was used to:

- improve the efficiency of the sample design, thereby making the survey estimates more reliable;
- apply different sample designs, such as disproportionate sample allocations, to specific groups of schools, such as those in particular states, provinces, or other regions;
- ensure all parts of a population were included in the sample; and
- ensure adequate representation of specific groups of the target population in the sample.

There were two types of stratification utilised: explicit and implicit. Explicit stratification consists of grouping schools into strata that will be treated independently from one another or as if they were separate school sampling frames. Examples of explicit stratification variables could be states or regions of a country. Implicit stratification consists essentially of sorting the schools uniquely within each explicit stratum by a set of designated implicit stratification variables. Examples of implicit stratification variables could be type of school, degree of urbanisation, or minority composition. This type of stratification is a way of ensuring a strictly proportional sample allocation of schools across all implicit strata. It can also lead to improved reliability of survey estimates, provided that the implicit stratification variables being considered are correlated with PISA achievement at the school level (Jaeger, 1984). Guidelines were provided in the *Sampling Guidelines FT12 Manual*[3] on choosing stratification variables that would possibly improve the sampling.

■ Figure 4.2 [Part 1/2] ■

Stratification variables used in PISA 2012

		Explicit stratification variables	Number of explicit strata	Implicit stratification variables
OECD	Australia	State/Territory (8); Sector (3); Certainty Selections	25	Geographic Zone (3); School Gender Composition (3); School Socio-economic Level (6); Numeracy Achievement Level (6); ISCED Level (3)
	Austria	Programme (17)	17	School Type (4); Region (9); Percentage of Girls (5)
	Belgium	Region (3); Form of Education – Flemish Community (5), French Community (3), German Community (2); Funding – Flemish Community (2), French Community and German Community (1); ISCED Level – Flemish Community and French Community (3), German Community (1); Educational Tracks – French Community (3), German Community and Flemish Community (1)	29	Grade Repetition – Flemish Community and French Community (5), German Community (1); Percentage of Girls – Flemish Community and French Community (4), German Community (1); School Type – French Community (4), German Community and Flemish Community (1)
	Canada	Province (10); Language (3); School Size (16); Certainty Selections	49	Urbanicity (3); Funding (2); ISCED Level (4)
	Chile	Funding type (3); School level (3); School track (4)	18	Percentage of Girls (6); Urbanicity (2); Region (4)
	Czech Republic	Programmes (6); Region (15); School Size (3)	81	School Size (3); Region for Programmes 3, 4, 5, 6 (15); School Gender Composition (3)
	Denmark	Immigrant Levels (5); Certainty Selections	6	School Type (8); ISCED Level (4); Urbanicity (6); Region (6)
	Estonia	Language (3); Certainty Selections	4	School Type (3); Urbanicity (2); County (15); Funding (2)
	Finland	Region (6); Urbanicity (2); Immigrant Levels (3); Certainty Selections	18	School Type (7)
	France	School Type (4); School Size (4)	6	School Type for small school strata (4); Funding (2)
	Germany	School Category (3); State, for normal schools (16)	18	State for other schools (17); School Type (6)
	Greece	Region (15); Funding (2)	16	School Type (3); Funding (2)
	Hungary	School Type (6)	6	Region (7); Mathematics Performance (6)
	Iceland	Region (9); School Size (4)	32	Urbanicity (2); ISCED Level (2)
	Ireland	School Size (3); School Type (4); Project Maths Pilot School (1); Non-aided school (1)	11	Socio-Economic Status Category (5); School Gender Composition Category (5)
	Israel	Language and Apprenticeship or not (3); School Orientation (3); Subsectors for Arabic (3); Gender (3)	12	ISCED Level (4); Group Size (3); SES (4); District (3)
	Italy	Region (21); Study Programme (5); Certainty Selections	104	Funding (2)
	Japan	Funding (2); School Type (2)	4	Levels of proportion of students taking University/ College Entrance Exams (4)
	Korea	School Level (2); School Type (2)	3	Urbanicity (3); School Gender Composition (3)
	Luxembourg	School Type (6)	6	School Gender Composition (3)
	Mexico	State (32); School Size (3); Certainty Selections	97	School Level (2); School Programme (7); Funding (2); Urbanicity (2)
	Netherlands	School Track (4)	4	Programme Category (7)
	New Zealand	School Size (3); Certainty Selections	4	School Decile (4); Funding (2); School Gender Composition (3); Urbanicity (2)
	Norway	School Level (3)	3	None
	Poland	School Type (4)	4	School Sub-type (2); Funding (2); Locality (4); Gender Composition (3)
	Portugal	Geographic Region (30); Certainty Selections	31	ISCED Level (3); Funding (2); Urbanicity (3)
	Slovak Republic	School Type (3); Region (8)	24	Sub-type (6); Language (3); Grade Repetition Level (25); Exam (11)
	Slovenia	Programme/Level (7)	7	Location/Urbanicity (5); Gender (3)
	Spain	Region (18); Funding (2); Linguistic Model for the Basque region (4); Certainty Selections	41	None
	Sweden	Funding (2); ISCED Level (2); Urbanicity (6)	12	Geographic LAN (22); Responsible Authority (4); Level of Immigrants (5); Income Quartiles (5)
	Switzerland	Language (3); School has Grade 9 or not (2); Canton (26); Public/Private (2); School Type (4); Certainty Selections	30	School Type (28); Canton (26)
	Turkey	Region (12); Programme Type (4)	38	School Type (18); Gender (3); Urbanicity (2); Funding (2)
	United Kingdom (excluding Scotland)	Country (3); School Type (4); Region – England (4), Northern Ireland (5), Wales (3); Certainty Selections	30	School Gender Composition (3); School Performance – England and Wales (6), Northern Ireland (1); Local Authority – England (151), Wales (22), Northern Ireland (1)
	United Kingdom (Scotland)	Funding (2); School Attainment (6)	9	Gender (3); Area Type (6)
	United States	Region (4); Funding (2)	8	Grade Span (5); Urbanicity (4); Minority Status (2); Gender (3); State (51)

■ Figure 4.2 [Part 2/2] ■

Stratification variables used in PISA 2012

		Explicit stratification variables	Number of explicit strata	Implicit stratification variables
Partners	Albania	Region (3); Urbanicity (2); Funding (2); Certainty Selections	13	ISCED2/Mixed (2)
	Argentina	Area (6)	6	Funding (2); Education type (3); Education level (9); Urbanicity (2); Secular/Religious (2)
	Brazil	State (27); Maintenance (3); Certainty Selections	81	Administration (3); DHI Quintiles (6); ISCED level (4); Urbanicity (2)
	Bulgaria	Region (11)	11	Type of School (8); Size of Settlement (5); Funding (3)
	Colombia	Region (6); Certainty Selections	7	Urbanicity (2); Funding (2); Weekend school or not (2); Gender (5); ISCED Programme Orientation (4)
	Costa Rica	School Type (5); Certainty Selections	6	Programme (2); Urbanicity (2); Shift (2); Region (27); ISCED Level (3)
	Croatia	Dominant Programme Type (6); Certainty Selections	7	Gender (3); Urbanicity (3); Region (6)
	Cyprus[1, 2]	ISCED Programme Orientation (3); Funding (2); Urbanicity (2)	8	Language (2); ISCED Level (3)
	Hong Kong-China	Funding (4)	4	Student Academic Intake (4)
	Indonesia	Indonesia (1)	1	Province (32); Funding (2); School Type and Level (5); National Exam Result (3)
	Jordan	School Type / Funding (7); Certainty Selections	8	Urbanicity (2); Gender (3); Level (2); Shift (2)
	Kazakhstan	Region (16); Language (13); Certainty Selections	59	Urbanicity (2); ISCED Level (3); ISCED Programme Orientation (2); Funding (2)
	Latvia	Urbanicity (4); Certainty Selections	5	School Type/Level (5)
	Liechtenstein	Liechtenstein (1)	1	Funding (2)
	Lithuania	Urbanicity (4); School Type (4); Certainty Selections	17	Funding (2)
	Macao-China	School Type (3); Programme (2); Language (5)	10	Gender (3); School Orientation (2); ISCED Level (2)
	Malaysia	School Category (6)	6	School Type (16); Urbanicity (2); State (16); Gender (3); ISCED Level (2)
	Montenegro	Programme (4); Region (3)	11	Gender (3)
	Peru	Funding (2); Urbanicity (2)	4	Region (26); Gender (3); School Type (7)
	Qatar	School Type (6)	6	Gender (3); Language (2); Level (5); Funding (2); Programme Orientation (3)
	Romania	Programme (2)	2	Language (2); Urbanicity (2); LIC Type (3)
	Russian Federation	Region (42)	42	Location/Urbanicity (9); School Type (8); School Sub-type (5);
	Serbia	Primary/Other (2); Region (6); School Type (4); Certainty Selections	17	Region (5); Programme (7)
	Shanghai-China	ISCED Level (4); ISCED Programme Orientation (2); Selectivity (3); Certainty Selections	6	Urbanicity (2); Funding (2); Vocational School Type (4)
	Singapore	Funding (2); School Level (2); Certainty Selections	4	Gender (3)
	Chinese Taipei	School type (7); Funding (2); Location (2); Certainty Selections	29	County/City area (22); School Gender (3)
	Thailand	Administration (7); School Type (3); Certainty Selections	17	Region (9); Urbanicity (2); Gender (3)
	Tunisia	Geographical Area (6); Urbanicity (3)	18	ISCED Level (3); Funding (2); Percentage of Repeaters (3)
	United Arab Emirates	Emirate (7); Curriculum (5); Funding (2); Certainty Selections	9	School Level (3); School Gender (3)
	Uruguay	Institutional Sector (4); School Level (3); Certainty Selections	11	Location/Urbanicity (4); Gender (4)
	Viet Nam	Broad Geographical Region (3); Funding (2); Urbanicity (3)	16	Economic Region (8); Province (63); School Type (6); Study Commitment (2)

1. Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

2. Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Figure 4.2 provides the explicit stratification variables used by each country, as well as the number of explicit strata found within each country. For example, Australia had eight explicit strata using states/territories which were then further delineated by three sectors and also had one explicit stratum for certainty selections, so that there were 25 explicit strata in total. Variables used for implicit stratification and the respective number of levels can also be found in Figure 4.2.

As the sampling frame was always finally sorted by school size, school size was also an implicit stratification variable, though it is not listed in Figure 4.2. The use of school size as an implicit stratification variable provides a degree of control over the student sample size so as to possibly avoid the sampling of too many relatively large schools or too many relatively small schools. A variable used for stratification purposes is not necessarily included in the PISA data files.

Assigning a measure of size to each school

For the probability proportional to size sampling method used for PISA, a Measure of Size (*MOS*) derived from *ENR* was established for each school on the sampling frame. *MOS* was generally constructed as: *MOS* = max(*ENR, TCS*). This differed slightly in the case of small schools treatment, discussed later.

Thus, the measure of size was equal to the enrolment estimate (*ENR*), unless enrolment was less than the *TCS*, in which case the measure of size was set equal to the target cluster size. In most countries, the *MOS* was equal to *ENR* or 35 students, whichever was larger.

As schools were sampled with probability proportional to size, setting the measure of size of small schools to 35 students was equivalent to drawing a simple random sample of small schools. That is, small schools had an equally likely chance of being selected to participate.

Countries participating in the PISA 2012 Financial Literacy (FL) option required a proportional increase to their initial *TCS* based on the expected booklet allocation rate within schools. It was expected for these countries that on average, 8 in 43 students would receive financial literacy booklets and 35 in 43 students would receive PISA booklets. Thus, an initial *TCS* of 35 was increased to a *TCS* of 43, and the *MOS* was then equal to *ENR* or 43 students, whichever was larger.

School sample selection

School sample allocation over explicit strata

The total number of schools to be sampled in each country needed to be allocated among the explicit strata so that the expected proportion of students in the sample from each explicit stratum was approximately the same as the population proportions of PISA-eligible students in each corresponding explicit stratum. There were two exceptions. If very small schools required under-sampling, students in them had smaller percentages in the sample than in the population. To compensate for the resulting loss of sample, the large schools had slightly higher percentages in the sample than the corresponding population percentages. The other exception occurred if only one school was allocated to any explicit stratum. In this case, two schools were allocated for selection in the stratum to aid with variance estimation.

Sorting the sampling frame

The *School Sampling Preparation Manual* indicated that, prior to selecting schools, schools in each explicit stratum were to be sorted by variables chosen for implicit stratification and finally by the *ENR* value within each implicit stratum. The schools were first to be sorted by the first implicit stratification variable, then by the second implicit stratification variable within the levels of the first implicit stratification variable, and so on, until all implicit stratification variables were used. This gave a cross-classification structure of cells, where each cell represented one implicit stratum on the school sampling frame. The sort order was alternated between implicit strata, from high to low and then low to high, etc., through all implicit strata within an explicit stratum.

Determining which schools to sample

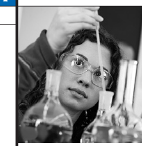
The PPS-systematic sampling method used in PISA first required the computation of a sampling interval for each explicit stratum. This calculation involved the following steps:

- recording the total measure of size, *S,* for all schools in the sampling frame for each specified explicit stratum;
- recording the number of schools, *D*, to be sampled from the specified explicit stratum, which was the number allocated to the explicit stratum;
- calculating the sampling interval, *I*, as follows: $I = S/D$; and
- recording the sampling interval, *I*, to four decimal places.

If any school in the stratum had a measure of size as large as or larger than the stratum sampling interval, that school became a school selected with certainty. Such a school was removed from its original explicit stratum and placed in a certainty stratum. The four steps above were then repeated in the original stratum, with now (*S* - certainty school measure of size) in the first step, and (*D*-1) schools for the second step. This process continues until there are no more schools selected with certainty.

Next, a random number had to be generated for each explicit stratum. The generated random number (*RN*) was from a uniform distribution between zero and one and was to be recorded to four decimal places.

The next step in the PPS selection method in each explicit stratum was to calculate selection numbers – one for each of the schools to be selected in the explicit stratum. Selection numbers were obtained using the following method:



- Obtaining the first selection number by multiplying the sampling interval, *I*, by the random number, *RN*. This first selection number was used to identify the first sampled school in the specified explicit stratum.
- Obtaining the second selection number by adding the sampling interval, *I*, to the first selection number. The second selection number was used to identify the second sampled school.
- Continuing to add the sampling interval, *I*, to the previous selection number to obtain the next selection number. This was done until all specified line numbers (1 through *number of schools to be sampled*) had been assigned a selection number.

Thus, the first selection number in an explicit stratum was $RN \times I$, the second selection number was $(RN \times I) + I$, the third selection number was $(RN \times I) + I + I$, and so on.

Selection numbers were generated independently for each explicit stratum, with a new random number generated for each explicit stratum.

Identifying the sampled schools

The next task was to compile a cumulative measure of size in each explicit stratum of the school sampling frame that assisted in determining which schools were to be sampled. Sampled schools were identified as follows.

Let Z denote the first selection number for a particular explicit stratum. It was necessary to find the first school in the sampling frame where the cumulative *MOS* equalled or exceeded Z. This was the first sampled school. In other words, if C_s was the cumulative *MOS* of a particular school S in the sampling frame and $C_{(s-1)}$ was the cumulative *MOS* of the school immediately preceding it, then the school in question was selected if: C_s was greater than or equal to Z, and $C_{(s-1)}$ was strictly less than Z. Applying this rule to all selection numbers for a given explicit stratum generated the original sample of schools for that stratum.

Box 4.1 **Illustration of probability proportional to size (PPS) sampling**

To illustrate these steps, suppose that in an explicit stratum in a participant country, the PISA-eligible student population is 105 000, then:

- the total measure of size, *S*, for all schools is 105 000;
- the number of schools, *D*, to be sampled is 150;
- calculating the sampling interval, *I*, 105 000/150 = 700;
- generate a random number, *RN*, 0.3230;
- the first selection number is 700 × 0.3230 = 226. This first selection number is used to identify the first sampled school in the specified explicit stratum;
- the second selection number is 226 + 700 = 926. The second selection number was used to identify the second sampled school; and
- the third selection number is 926 + 700 = 1 626. The third selection number was used to identify the third sampled school, and so on until the end of the school list is reached. This will result in a school sample size of 150 schools.

The table below also provides these example data. The school that contains the generated selection number within its cumulative enrolment is selected for participation.

Table 4.1 Examples of PPS sampling

School	*MOS*	Cumulative *MOS* (C_s)	Selection number	School selection
001	550	550	226	Selected
002	364	914		
003	60	974	926	Selected
004	93	1067		
005	88	1155		
006	200	1355		
007	750	2105	1626	Selected
008	72	2177		
009	107	2284		
010	342	2626	2326	Selected
011	144	2770		
...	...	...	...	...

Identifying replacement schools

Each sampled school in the Main Survey was assigned two replacement schools from the school sampling frame, if possible, identified as follows. For each sampled school, the schools immediately preceding and following it in the explicit stratum, which was ordered within by the implicit stratification, were designated as its replacement schools. The school immediately following the sampled school was designated as the first replacement and labelled R_1, while the school immediately preceding the sampled school was designated as the second replacement and labelled R_2. The *School Sampling Preparation Manual* noted that in small countries, there could be problems when trying to identify two replacement schools for each sampled school. In such cases, a replacement school was allowed to be the potential replacement for two sampled schools (a first replacement for the preceding school, and a second replacement for the following school), but an actual replacement for only one school. Additionally, it may have been difficult to assign replacement schools for some very large sampled schools because the sampled schools appeared close to each other in the sampling frame. There were times when it was only possible to assign a single replacement school when two consecutive schools in the sampling frame were sampled, or none for the second of three consecutive sampled schools. That is, no unsampled schools existed between sampled schools.

Exceptions were allowed if a sampled school happened to be the last school listed in an explicit stratum. In this case the two schools immediately preceding it were designated as replacement schools. Similarly, for the first school listed in an explicit stratum, in which case the two schools immediately following it were designated as replacement schools.

Assigning school identifiers

To keep track of sampled and replacement schools in the PISA database, each was assigned a unique, three-digit school code and two-digit stratum code (corresponding to the explicit strata) sequentially numbered starting with one within each explicit stratum. For example, if 150 schools are sampled from a single explicit stratum, they are assigned identifiers from 001 to 150. First replacement schools in the Main Survey are assigned the school identifier of their corresponding sampled schools, incremented by 300. For example, the first replacement school for sampled school 023 is assigned school identifier 323. Second replacement schools in the Main Survey are assigned the school identifier of their corresponding sampled schools, but incremented by 600. For example, the second replacement school for sampled school 136 took the school identifier 736.

Tracking sampled schools

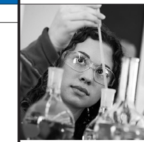
NPMs were encouraged to make every effort to confirm the participation of as many sampled schools as possible to minimise the potential for non-response biases. They contacted replacement schools after all contacts with sampled schools were made. Each sampled school that did not participate was replaced if possible. If both an original school and a replacement participated, only the data from the original school were included in the weighted data provided that at least 50% of the PISA-eligible, non-excluded students had participated. If this was not the case, it was permissible for the original school to be labelled as a nonrespondent and the replacement school as the respondent, provided that the replacement school had at least 50% of the PISA-eligible, non-excluded students as participants.

Special school sampling situations

Treatment of small schools

In PISA, schools were classified as very small, moderately small or large. A school was classified as large if it had an *ENR* above the *TCS* (35 students in most countries). A moderately small school had an *ENR* in the range of one-half the *TCS* to *TCS* (18 to 35 students in most countries). A very small school had an *ENR* less than one-half the *TCS* (17 students or fewer in most countries). New for PISA 2012, very small schools were further classified as very small schools with an *ENR* of zero, one, or two students and very small schools with an *ENR* greater than two students but less than one-half the *TCS*. Unless they received special treatment in the sampling, the occurrence of small schools in the sample will reduce the sample size of students for the national sample to below the desired target because the within-school sample size would fall short of expectations. A sample with many small schools could also be an administrative burden with many testing sessions with few students. To minimise these problems, procedures were devised for managing small schools in the sampling frame.

To balance the two objectives of selecting an adequate sample of small schools but not too many small schools so as to hurt student yield, a procedure was recommended that assumed the underlying idea of under-sampling the very small schools by a factor of two (those with an *ENR* greater than two but less than one-half the *TCS*) and under-sampling the



very small schools with zero, one, or two students by a factor of four and to proportionally increasing the number of large schools to sample. To determine whether very small schools should be undersampled and if the sample size needed to be increased to compensate for small schools, the following test was applied.

- If the percentage of students in very small schools ($ENR<TCS/2$) was 1% or MORE, then very small schools were undersampled and the school sample size increased.
- If the percentage of students in very small schools ($ENR<TCS/2$) was LESS than 1% and the percentage of students in moderately small schools ($TCS/2<ENR<TCS$) was 4% or MORE, then there was no required undersampling of very small schools but the school sample size was increased.

If none of these conditions were true, then the small schools contained such a small proportion of the PISA population that they were unlikely to reduce the sample below the desired target. In this case, no undersampling of very small schools was needed nor an increase to the school sample size to compensate for small schools.

If the number of very small schools was to be controlled in the sample without creating explicit strata for these small schools, this was accomplished by assigning a measure of size (*MOS*) of $TCS/2$ to those very small schools with an *ENR* greater than two but less than $TCS/2$ and a measure of size equal to the $TCS/4$ for the very small schools with an *ENR* of zero, one, or two. In effect, very small schools with a measure of size equal to $TCS/2$ were under-sampled by a factor of two (school probability of selection reduced by half), and the very small schools with a measure of size equal to $TCS/4$ were under-sampled by a factor of four (school probability of selection reduced by three-fourths). This was accomplished as follows.

The formulae below assume an initial target school sample size of 150 and a target student sample size of 5 250.

- *Step 1:* From the complete sampling frame, find the proportions of total *ENR* that come from very small schools with *ENR* of zero, one or two (*P1*), very small schools with *ENR* greater than two but fewer than $TCS/2$ (*P2*), moderately small schools (*Q*), and large schools (*R*). Thus, $P1 + P2 + Q + R = 1$
- *Step 2:* Calculate the value *L*, where $L = 1.0 + 3(P1)/4 + (P2)/2$. Thus *L* is a positive number slightly more than 1.0.
- *Step 3:* The minimum sample size for large schools is equal to $150 \times R \times L$, rounded up to the nearest integer. It may need to be enlarged because of national considerations, such as the need to achieve minimum sample sizes for geographic regions or certain school types.
- *Step 4:* Calculate the mean value of *ENR* for moderately small schools (*MENR*), and for very small schools (*V1ENR and V2ENR*). *MENR* is a number in the range of *TCS/2* to *TCS*, *V2ENR* is a number larger than two but no greater than *TCS/2*, and *V1ENR* is a number in the range of zero to two.
- *Step 5:* The number of schools that must be sampled from the moderately small schools is given by: $(5\,250 \times Q \times L)/(MENR)$.
- *Step 6:* The number of schools that must be sampled from the very small schools (type *P2)* is given by: $(2\,625 \times P2 \times L)/(V2ENR)$.
- Step 7: The number of schools that must be sampled from the very small schools (type *P1)* is given by: $(1\,313 \times P1 \times L)/(V1ENR)$.

To illustrate the steps, suppose that in a participant country, the *TCS* is equal to 35 students, with 10% of the total enrolment of 15-year-olds in moderately small schools, and 5% in each type of very small schools, *P1* and *P2*. Suppose that the average enrolment in moderately small schools is 25 students, in very small schools (type *P2*) it is 12 students, and in very small schools (type *P1*) it is 1.5 students.

- *Step 1:* The proportions of total *ENR* from very small schools is $P1=0.05$ *and* $P2 = 0.05$, from moderately small schools is $Q = 0.1$, and from large schools is $R = 0.8$. It can be shown that $0.05 + 0.05 + 0.1 + 0.8 = 1.0$.
- *Step 2:* Calculate the value *L*: $L = 1.0 + 3(0.05)/4 + (0.05)/2$. Thus $L = 1.0625$.
- *Step 3:* The minimum sample size for large schools is equal to $150 \times 0.8 \times 1.0625 = 127.5$. That is, at least 128 (rounded up to the nearest integer) of the large schools must be sampled.
- *Step 4:* The mean value of *ENR* for moderately small schools (*MENR*) is given in this example as 25, very small schools of type *P2* (*V2ENR*) as 12, and very small schools of type *P1* (*V1ENR*) as 1.5.
- *Step 5:* The number of schools that must be sampled from the moderately small schools is given by $(5\,250 \times 0.1 \times 1.0625)/25 = 22.3$. At least 23 (rounded up to the nearest integer) moderately small schools must be sampled.

- *Step 6:* The number of schools that must be sampled from the very small schools (type *P2*) is given by (2 625 × 0.05 × 1.0625)/12 = 11.6. At least 12 (rounded up to the nearest integer) very small schools of type *P2* must be sampled.
- *Step 7:* The number of schools that must be sampled from the very small schools (type *P1*) is given by (1 313 × 0.05 × 1.0625)/1.5 = 46.5. At least 47 (rounded up to the nearest integer) very small schools of type *P1* must be sampled.

Combining these different sized school samples gives a total sample size of 128 + 23 + 12 + 47 = 210 schools. Before considering school and student non-response, the larger schools will yield an initial sample of approximately 128 × 35 = 4 480 students. The moderately small schools will give an initial sample of approximately 23 × 25 = 575 students, very small schools of type *P2* will give an initial sample size of approximately 12 × 12 = 144 students, and very small schools of type *P1* will give an initial sample size of approximately 47 × 1.5 = 70.5, i.e., 71 students. The total initial sample size of students is therefore 4 480 + 575 + 144 + 71 = 5 270.

This procedure, called small school analysis, was done not just for the entire school sampling frame, but for each individual explicit stratum. An initial allocation of schools to explicit strata provided the starting number of schools and students to project for sampling in each explicit stratum. The small school analysis for a single unique explicit stratum indicated how many very small schools of each type (assuming under-sampling, if needed), moderately small schools and large schools would be sampled in that stratum. Together, these provided the final sample size, *n*, of schools to select in the stratum. Based on the stratum sampling interval and random start, large, moderately small, and very small schools were sampled in the stratum, to a total of *n* sampled schools. Because of the random start, it was possible to have more or less than expected of the very small schools of either type, *P1* or *P2*, of the moderately small schools, and of the large schools. The total number of sampled schools however was fixed at *n*, and the number of expected students to be sampled was always approximate to what had been projected from the unique stratum small school analysis.

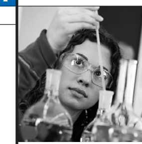
Sampling for Problem Solving assessment (PS) component

Forty-four countries and economies participated in the Problem Solving assessment (PS) conducted via computer: Australia, Austria, Belgium, Brazil, Bulgaria, Canada, Chile, Colombia, Croatia, Cyprus,[4] the Czech Republic, Denmark, Estonia, Finland, France, Germany, Hong Kong-China, Hungary, Ireland, Israel, Italy, Japan, Korea, Macao-China, Malaysia, Montenegro, the Netherlands, Norway, Poland, Portugal, the Russian Federation, Serbia, Shanghai-China, Singapore, the Slovak Republic, Slovenia, Spain, Sweden, Chinese Taipei, Turkey, the United Arab Emirates, the United Kingdom (England only), the United States, and Uruguay. Of these 44 countries and economies, 32 also did the optional Computer-Based Assessment of Literacies in Mathematics and Reading (CBAL). Collectively, the computer-based assessment for PISA 2012 (Problem Solving-only or Problem Solving plus CBAL) was referred to as "CBA". When a country participated in CBA, it was expected that CBA student sampling would occur in every PISA sampled and participating school.

Students selected for the computer-based assessments were a subsample of those selected for the paper-based assessments. The overall sample size requirement was 2 100 CBA students for countries that did only Problem Solving (PS) and 2 700 CBA students for countries that did both PS and CBAL. The recommended CBA Target Cluster Size (ETCS) was 14 students per sampled school for PS-only and 18 students per sampled school for PS and CBAL. Unlike the computer-based assessments in the previous PISA cycle, a student's valid participation in the PISA 2012 CBA did not require their participation in the main paper-based PISA assessment. At least 70% of the CBA subsample within each school was expected to participate in the CBA in order to achieve reliable CBA achievement score generation. The CBA student subsample was selected at the same time that the PISA student sample was selected in each school by the student sampling software, *KeyQuest*.

The actual CBA student sample size at each school was calculated with *KeyQuest*, as the minimum of the ETCS, and the number of sampled PISA students. Arrangements had to be made at the school level to either bring in laptops, or to have extra sessions to alleviate any computer resource problems.

If a country had a large PISA school sample and wished to subsample the PISA sampled schools where CBA student sampling would be done, this became an additional national option. Three countries, Brazil, Italy and Spain, chose to have schools subsampled for CBA from their large national school sample. The schools for CBA were subsampled from sampled schools in each explicit stratum. The number to subsample for CBA in each stratum was based on how many schools would have been needed from each explicit stratum for a school sample of 150 schools. Any schools selected



with certainty for the large national school sample and placed in their own stratum, were added back to their original strata for the subsampling of CBA schools. Then schools that were certainty schools for the large national school sample were subsampled with Probability Proportional to Size, while schools that were sampled initially with a probability of less than 1.0 were subsampled with equal probability. The respective probabilities were calculated in such a way that CBA sample of schools was selected overall with Probability Proportional to Size.

PISA and national study overlap control

The Main Survey for PISA 2012 and a national (non-PISA) study were to occur at approximately the same time in some participating countries. Because of the potential for increased burden, an overlap control procedure was used for two countries (Austria and the United States) who requested for there to be a minimum incidence of the same schools being sampled for both PISA and their national (non-PISA) study. This overlap control procedure required that the same school identifiers be used on the PISA and the national study school frames for the schools in common across the two assessments.

The national study samples were usually selected before the PISA samples. Thus, for countries requesting overlap control, the national study centre supplied the PISA Consortium with their school frames, national school IDs, each school's probability of selection, and an indicator showing which schools had been sampled for the national study.

Sample selections for PISA and the national study could totally avoid overlap of schools if schools which would have been selected with high probability for either study had their selection probabilities capped at 0.5. Such an action would make each study's sample slightly less than optimal, but this might be deemed acceptable when weighed against the possibility of low response rates due to the burden of participating in two assessments. This was not requested for PISA 2012. Therefore, if any schools had probabilities of selection greater than 0.5 on either study frame, these schools had the possibility to be selected to be in both studies.

There were also two other occurrences of overlap control. In the case of Colombia, after sample selection, a requirement for an oversample for a particular region was newly identified. A new stratum had to be added for that region for new sample selection. The sample had to be reselected for the stratum which had previously had those region's schools, as well as for all other region strata. Maximum overlap control ensured that all previously sampled schools not from that region would be sampled again (data collection had already started), along with the new sample for the newly stratified region. The other occurrence of overlap control involved the Russian Federation PISA sample. The Russian Federation had one adjudicated region for PISA 2012 which was separately sampled. The main Russian Federation sample also had several schools sampled from that region. To avoid having the same schools selected for the region in the two samples, minimal overlap control was applied.

To control overlap of schools between PISA and another sample, the sample selection of schools for PISA adopted a modification of an approach due to Keyfitz (1951), based on Bayes Theorem. To use PISA and ICCS (the International Civics and Citizenship Study, a concurrent international study conducted at the time of PISA 2009) in an example of the overlap control approach to minimise overlap, suppose that *PROBP* is the PISA probability of selection and *PROBI* is the ICCS probability of selection. Then a conditional probability of a school's selection into PISA (*CPROB)* is determined as follows:

4.1

$$CPROB = \begin{cases} \max\left[0, \left(\dfrac{PROBI + PROBP - 1}{PROBI}\right)\right] & \textit{if the school was an ICCS school} \\[2ex] \min\left[1, \dfrac{PROBP}{(1 - PROBI)}\right] & \textit{if the school was not an ICCS school} \\[2ex] PROBP \quad \textit{if the school was not an ICCS eligible school} & \end{cases}$$

Then a conditional *CMOS* variable was created to coincide with these conditional probabilities as follows:

$$CMOS = CPROB \times \text{stratum sampling interval}$$

The PISA school sample was then selected using the line numbers created as usual (see earlier section), but applied to the cumulated *CMOS* values (as opposed to the cumulated *MOS* values). Note that it was possible that the resulting PISA sample size could be slightly lower or higher than the originally assigned PISA sample size, but this was deemed acceptable.

Monitoring school sampling

For PISA 2012, as in the previous cycles, it was a strong recommendation that the PISA Consortium select the school samples rather than the participating countries. This was again incorporated into the 2012 procedures to alleviate the weighting difficulties caused by receiving school sampling frame files in many different formats. Japan was the only participant that selected their own school sample, doing so for reasons of confidentiality.

Sample selection for Japan was replicated by the PISA Consortium to ensure quality in this case. All other participating countries' school samples were selected by and checked in detail by the PISA Consortium. To enable this, all countries were required to submit sampling information on forms associated with the following various sampling tasks:

- time of testing and age definition for both the Field Trial and Main Survey were captured on Sampling Task 1 at the time of the Field Trial, with updates being possible before the Main Survey;
- information about stratification for the Field Trial and for the Main Survey was recorded on Sampling Task 2;
- forms or data associated with Sampling Tasks 3, 4, 5 and 6 were all for the Field Trial;
- the national desired target population information for the Main Survey was captured on the form associated with Sampling Task 7a;
- information about the defined national target population was recorded on the form associated with Sampling Task 7b;
- the description of the sampling frame was noted on the form associated with Sampling Task 8a; and
- the school sampling frame was created in one spreadsheet and the list of any excluded schools in a second spreadsheet associated with Sampling Task 8b.

The PISA Consortium completed school sampling and, along with the school sample, returned other information (small school analyses, school allocation, and a spreadsheet that countries could use for tracking school participation). Figure 4.3 provides a summary of the information required for each sampling task and the timetables (which depended on national assessment periods).

■ Figure 4.3 ■

Schedule of school sampling activities

Activity	Submit to Consortium	Due Date
Update time of testing and age definition of population to be tested	Sampling Task 1 – time of testing and age definition	Update what was submitted at the time of the Field Trial, two months before the school sample is to be selected
Finalise explicit and implicit stratification variables	Sampling Task 2 – stratification and other information	Update what was submitted at the time of the Field Trial, two months before the school sample is to be selected
Define national desired target population	Sampling Task 7a – national desired target population	Submit two months before the school sample is to be selected
Define national defined target population	Sampling Task 7b – national defined target population	Submit two months before the school sample is to be selected
Create and describe sampling frame	Sampling Task 8a – sampling frame description	Submit two months before the school sample is to be selected
Submit sampling frame	Sampling Task 8b – sampling frame (in one Excel® sheet), and excluded schools (in another Excel® sheet)	Submit two months before the school sample is to be selected
Decide how to treat small schools; finalise sample size requirements	Sampling Task 9 – treatment of small schools; sample allocation by explicit strata	The Consortium will complete and return this information to the NPM about one month before the school sample is to be selected
Describe population within strata	Population counts by strata	The Consortium will complete and return this information to the NPM when the school sample is sent to the NPM
Select the school sample	Sampling Task 10 – school sample selection	The Consortium will return the sampling frame to the NPM with sampled schools and their replacement schools identified and with PISA IDs assigned when the school sample is selected
Review and agree to the sampling form required as input to *KeyQuest*	Sampling Task 11 – reviewing and agreeing to the Sampling Form for *KeyQuest* (SFKQ)	Countries had one month after their sample was selected to agree to their SFKQ
Submit sampling data	Sampling Task 12 – school participation information and data validity checks	Submit within one month of the end of the data collection period

Once received from each participating country, each set of information was reviewed and feedback was provided to the country. Forms were only approved after all criteria were met. Approval of deviations was only given after discussion and agreement by the PISA Consortium. In cases where approval could not be granted, countries were asked to make revisions to their sample design and sampling forms and resubmit.

Checks that were performed in the monitoring of each set of information are described in the following text. All entries were observed in their own right but those below were additional matters explicitly examined.

As part of the initial pre-form checks, all special situations known about the participating country were verified with the country. Such special situations included, *TCS* values different from 35 students, whether or not the computer-based assessment was being conducted and if so, its ETCS value, whether or not the financial literacy assessment was being conducted, whether or not overlap control procedures with a national (non-PISA) survey were required, whether or not there was any regional or other type of oversampling, whether or not the UH (one hour) booklet would be used, and whether or not any grade or other type of student sampling would be used. Additionally, any country with fewer than 4 500 or just over 4 500 assessed students in either PISA 2006 or 2009 had increased school sample sizes discussed and agreed upon. Additionally, countries which had too many PISA 2009 exclusions were warned about not being able to exclude any schools in the field for PISA 2012. Finally, any country with effective student sample sizes less than 400 in PISA 2009 also had increased school sample sizes discussed and agreed upon.

Sampling Task 1: Time of testing and age definition

- Assessment dates had to be appropriate for the selected target population dates.
- Assessment dates could not cover more than a 42-day period unless agreed upon.
- Assessment dates could not be within the first six weeks of the academic year.
- If assessment end dates were close to the end of the target population birth date period, NPMs were alerted not to conduct any make-up sessions beyond the date when the population births dates were valid.

Sampling Task 2: Stratification (and other information)

- Since explicit strata are formed to group similar schools together to reduce sampling variance and to ensure representativeness of students in various school types, using variables that might be related to outcomes, each participating country's choice of explicit stratification variables was assessed. If a country was known to have school tracking or distinct school programmes and these were not among the explicit stratification variables, a suggestion was made to include this type of variable.
- Dropping variables or reducing levels of stratification variables used in the past was discouraged and only accepted if the National Centre could provide strong reasons for doing so.
- Levels of variables and their codes were checked for completeness.
- If no implicit stratification variables were noted, suggestions were made about ones that might be used. In particular, if a country had schools with only male or only female students, and school gender composition was not among the implicit stratification variables, a suggestion was made to include this type of variable to ensure no sample gender imbalances. Similarly, if there were ISCED school level splits, the ISCED school level was also suggested as an implicit stratification variable.
- Without overlap control there is nearly as good control over the sample whether explicit or implicit strata are used. With overlap control some control is lost when using implicit strata, but not when using explicit strata. For countries which wanted overlap control with a national non-PISA survey, as many as possible of their implicit stratification variables were made explicit stratification variables.
- Checks were done to ensure there was only one student sampling option per explicit stratum.

Sampling Task 7a: National desired target population

- The total national number of 15-year olds of participating countries was compared with those from previous cycles. Differences, and any kind of trend, were queried.
- Large deviations between the total national number of 15-year-olds and the enrolled number of 15-year-olds were questioned.
- Large increases or decreases in enrolled population numbers compared to those from previous PISA cycles were queried, as were increasing or decreasing trends in population numbers since PISA 2000.

- Any population to be omitted from the international desired population was noted and discussed, especially if the percentage of 15-year-olds to be excluded was more than 0.5% or if it was substantially different or not noted for previous PISA cycles.
- Calculations did not have to be verified as in previous cycles as such data checks were built into the form.
- For any countries using a three-stage design, a Sampling Task 7a form also needed to be completed for the full national desired population as well as for the population in the sampled regions.
- For countries having adjudicated regions, a Sampling Task 7a form was needed for each region.
- Data sources and the year of the data were required. If websites were provided with an English page option, the submitted data was verified against those sources.

Sampling Task 7b: National defined target population

- The population value in the first question needed to correspond with the final population value on the form for Sampling Task 7a. This was accomplished through built-in data checks.
- Reasons for excluding schools for reasons other than special education needs were checked for appropriateness (i.e. some operational difficulty in assessing the school). In particular, school-level language exclusions were closely examined to check correspondence with what had been noted about language exclusions on Sampling Task 2.
- Exclusion types and extents were compared to those recorded for PISA 2009 and previous cycles. Differences were queried.
- The number and percentage of students to be excluded at the school level and whether the percentage was less than the guideline for maximum percentage allowed for such exclusions were checked.
- Reasonableness of assumptions about within-school exclusions was assessed by checking previous PISA coverage tables. If there was an estimate noted for "other", the country was queried for reasonableness about what the "other" category represented. If it was known the country had schools where some of the students received instruction in minority languages not being tested, an estimate for the within-school exclusion category for "no materials available in the student's language of instruction" was necessary.
- Form calculations were verified through built-in data checks, and the overall coverage figures were assessed.
- If it was noted that there was a desire to exclude schools with only one or two PISA-eligible students at the time of contact, then the school sampling frame was checked for the percentage of population that would be excluded. If a country had not exceeded the 2.5% school-exclusion guideline, excluding such schools was a possibility. Furthermore, if these schools would account for not more than 0.5% of students, and if within-school exclusions looked similar to the past and were within 2.5%, then the exclusion of these schools at the time of contact was agreed upon. There was one caveat for the agreement – that such exclusion not cause entire strata to be missing from the student data.
- The population figures on this form after school-level exclusions were compared against the aggregated school sampling frame enrolment. Differences were queried.
- For any countries using a three-stage design, a Sampling Task 7b form was also needed to be completed for the full national defined population as well as for the population in the sampled regions.
- For countries having adjudicated regions, a Sampling Task 7b form was needed for each region.
- Data sources and the year of the data were required. If websites were provided with an English page option, the submitted data was verified against those sources.

Sampling Task 8a: Sampling frame description

- Special attention was given to countries who reported on this form that a three-stage sampling design was to be implemented and additional information was sought from countries in such cases to ensure that the first-stage sampling was done adequately.
- The type of school-level enrolment estimate and the year of data availability were assessed for reasonableness.
- Countries were asked to provide information for each of various school types,[5] whether those schools were included on or excluded from the sampling frame, or the country did not have any of such schools. The information was matched to the different types of schools containing PISA students noted on Sampling Task 2. Any discrepancies were queried.
- Any school types noted as being excluded were verified as school-level exclusions on the Sampling Task 7b form. Any discrepancies were queried.

Sampling Task 8b: Sampling frame

- On the spreadsheet for school-level exclusions, the number of schools and the total enrolment figures, as well as the reasons for exclusion, were checked to ensure correspondence with values reported on the Sampling Task 7b form detailing school-level exclusions. It was verified that this list of excluded schools did not have any schools which only had one or two PISA-eligible students, as these schools were not to be excluded from the school sampling frame. Checks were done to ensure that excluded schools did not still appear on the other spreadsheet containing the school sampling frame.
- All units on the school sampling frame were confirmed to be those reported on the Sampling Task 2 as sampling frame units. The sampling unit frame number was compared to the corresponding frame for PISA 2009 as well as previous cycles. Differences were queried.
- NPMs were queried about whether or not they had included schools with grades 7 or 8, or in some cases those with grades 10 or higher, which could potentially have PISA-eligible students at the time of assessment even if the school currently did not have any.
- NPMs were queried about whether they had included vocational or apprenticeship schools, schools with only part-time students, international or foreign schools or schools not under the control of the Ministry of Education or any other irregular schools that could contain PISA-eligible students at the time of the assessment, even if such schools were not usually included in other national surveys.
- The frame was checked for all required variables: a national school identifier with no duplicated values, a variable containing the school enrolment of PISA-eligible students, and all the explicit and implicit stratification variables and all related levels as noted on Sampling Task 2, and that none had missing values.
- Any additional school sampling frame variables were assessed for usefulness. In some instances other variables were noted on the school frame that might also have been useful for stratification.
- The frame was checked for schools with only one or two PISA-eligible students. If no schools were found with extremely low counts, but the country's previous sampling frames had some, this was queried.
- The frame was checked for schools with zero enrolment. If there were none, this was assessed for reasonableness. If some existed, it was verified with the NPM that these schools could possibly have PISA-eligible students at the time of the assessment.

Sampling Task 9: Treatment of small schools and the sample allocation by explicit strata

- All explicit strata had to be accounted for on the form for Sampling Task 9.
- All explicit strata population entries were compared to those determined from the sampling frame.
- All small school analysis calculations were verified.
- It was verified that separate small school analyses were done for adjudicated or non-adjudicated oversampled regions (if these were different from explicit strata).
- Country specified sample sizes were monitored, and revised if necessary, to be sure minimum sample sizes for adjudicated regions were being met.
- The calculations for school allocation were checked to ensure that schools were allocated to explicit strata based on explicit stratum student percentages and not explicit stratum school percentages, that all explicit strata had at least two allocated schools, and that no explicit stratum had only one remaining non-sampled school.
- It was verified that the allocation matched the results of the explicit strata small school analyses, with allowances for random deviations in the numbers of very small, moderately small, and large schools to be sampled in each explicit stratum.
- The percentage of students in the sample for each explicit stratum had to be approximate to the percentage in the population for each stratum (except in the case of oversampling).
- The overall number of schools to be sampled was checked to ensure that at least 150 schools would be sampled.
- The overall number of students to be sampled was checked to ensure that at least 5 250 students would be sampled.
- Previous PISA response rates were reviewed and if deemed necessary, sample size increases were suggested.

Sampling Task 10: School sample selection

- All calculations were verified, including those needed for national study overlap control.
- Particular attention was paid to the required four decimal places for the sampling interval and the generated random number.

- The frame was checked for proper sorting according to the implicit stratification scheme, for enrolment values, and the proper assignment of the measure of size value, especially for very small and moderately small schools. The assignment of replacement schools and PISA identification numbers were checked to ensure that all rules established in the *Sampling Preparation Manual* were adhered to.

Sampling Task 11: Reviewing and agreeing to the Sampling Form

- The form for Sampling Task 11 was prepared as part of the sample selection process. After the PISA Consortium verified that all entries were correct, NPMs had one month to perform the same checks and to agree to the content in this form.

Sampling Task 12: School participation and data validity checks

- Extensive checks were completed on Sampling Task 12 data since it would inform the weighting process. Checks were done to ensure that school participation statuses were valid, that student participation statuses had been correctly assigned, and that all student sampling data required for weighting were available and correct for all student sampling options. Quality checks also highlighted schools having only one grade with PISA-eligible students, only one gender of PISA-eligible students, or schools which had noticeable differences in enrolled student counts than expected based on sampling frame enrolment information. Such situations were queried.
- Large differences in overall grade and gender distributions compared to unweighted 2009 data were queried.
- These data also provided initial unweighted school and student response rates. Any potential response rate issues were discussed with NPMs if it seemed likely that a non-response bias report might be needed.
- Large differences in response rates compared to PISA 2009 were queried.
- Participating countries doing CBA were expected to have data for CBA related variables. Any inconsistent or unexpected CBA data entries were queried.

Student samples

Student selection procedures in the Main Survey were the same as those used in the Field Trial. Student sampling was generally undertaken using the PISA Consortium software, *KeyQuest*, at the National Centres from lists of all PISA-eligible students in each school that had agreed to participate. These lists could have been prepared at national, regional, or local levels as data files, computer-generated listings, or by hand, depending on who had the most accurate information. Since it was important that the student sample be selected from accurate, complete lists, the lists needed to be prepared slightly in advance of the testing period and had to list all PISA-eligible students. It was suggested that the lists be received one to two months before the testing period so that the NPM would have adequate time to select the student samples.

Five countries (Chile, Germany, Iceland, Slovenia and Switzerland) chose student samples that included students aged 15 and/or enrolled in a specific grade (e.g. Grade 10). Thus, a larger overall sample, including 15-year-old students and students in the designated grade (who may or may not have been aged 15) was selected. The necessary steps in selecting larger samples are noted where appropriate in the following details:

- Iceland and Switzerland, for part of its grade sample only, used the standard method of direct student sampling described here.
- For Iceland, the sample constituted a de facto grade sample because nearly all of the students in the grade to be sampled were PISA-eligible 15-year-olds.
- Switzerland supplemented the standard sampling method with two list-based variations: one variation selected *TCS* students from just the PISA-eligible non-Grade 9 students followed by a census of Grade 9 students, and the other variation selected not more than *TCS* students from a list containing both PISA-eligible students and Grade 9 students.
- Germany supplemented the standard sampling method with an additional sample of grade-eligible students which was selected by first selecting Grade 9 classes within PISA sampled schools that had this grade.
- Slovenia used the direct student sampling method for two within-school samples, one for PISA-eligible students and a second sample for Grade 10 students that were not PISA-eligible.
- In Chile, the standard method was supplemented with additional grade-eligible students from a sample of Grade 10 classes within PISA sampled schools that had this grade.

Mexico selected a Grade 12 sample but accomplished this by having a completely separate sample of schools containing Grade 12 students.

Preparing a list of age-eligible students

Each school drawing an additional grade sample was to prepare a list of *age* and grade-eligible students that included all PISA-eligible students in the designated grade (e.g. Grade 10); and all other 15-year-old students (using the appropriate 12-month age span agreed upon for each participating country) currently enrolled in other grades. This form was referred to as a student listing form. The following were considered important:

- Age-eligible students were all students born in 1996 (or the appropriate 12-month age span agreed upon for the participating country).
- The list was to include students who might not be tested due to a disability or limited language proficiency.
- Students who could not be tested were to be excluded from the assessment after the student sample was selected. It was stressed that students were to be excluded after the students sample was drawn, not prior.
- It was suggested that schools retain a copy of the student list in case the NPM had to contact the school with questions.
- Student lists were to be up-to-date at the time of sampling rather than a list prepared at the beginning of the school year. Students were identified by their unique student identification numbers.

Selecting the student sample

Once NPMs received the list of PISA-eligible students from a school, the student sample was to be selected and the list of selected students (i.e. the student tracking form) returned to the school. NPMs were required to use *KeyQuest*, the PISA Consortium sampling software, to select the student samples unless otherwise agreed upon. For PISA 2012, all countries used *KeyQuest*.

Preparing instructions for excluding students

PISA was a timed assessment administered in the instructional language(s) of each participating country and designed to be as inclusive as possible. For students with limited assessment language(s) experience or with physical, mental, or emotional disabilities who could not participate, PISA developed instructions in cases of doubt about whether a selected student should be assessed. NPMs used the guidelines to develop any additional instructions; school co-ordinators and test administrators needed precise instructions for exclusions. The national operational definitions for within-school exclusions were to be clearly documented and submitted to the PISA Consortium for review before testing.

Sending the student tracking form to the School Co-ordinator and Test Administrator

The School Co-ordinator needed to know which students were sampled in order to notify students, parents and teachers to update information and to identify students to be excluded. The student tracking form was therefore sent approximately two weeks before the testing period. It was recommended that a copy of the tracking form be kept at the National Centre and the NPM send a copy of the form to the test administrator in case the school copy was misplaced before the assessment day. The Test Administrator and School Co-ordinator manuals (see Chapter 6) both assumed that each would have a copy.

In the interest of ensuring PISA was as inclusive as possible, student participation and reasons for exclusion were separately coded in the student tracking form. This allowed for students with Special Education Needs (SEN) to be included when their SEN was not severe enough to be a barrier to their participation. The participation status could therefore detail, for example, that a student participated and was not excluded for SEN reasons even though the student was noted with a special education need. Any student whose participation status indicated they were excluded for SEN reasons had to have an SEN code that explained the reason for exclusion. It was important that these criteria be followed strictly for the study to be comparable within and across participating countries. When in doubt, the student was included. The instructions for excluding students are provided in the PISA Technical Standards (see Annex F).

Definition of school

Although the definition of a "school" is difficult, PISA generally aims to sample whole schools as the first stage units of selection, rather than programmes or tracks or shifts within schools, so that the meaning of "between school variance" is more comparable across countries.

There are exceptions to this, such as when school shifts are actually more like separate schools than part of the same overall school. However, in some countries with school shifts this is not the case and therefore whole schools are used as the primary sampling unit. Similarly, many countries have schools with different tracks/programs but generally it is

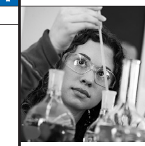
recommended again that the school as a whole should be used as the primary sampling unit. There are some exceptions, such as the schools being split for sampling in previous PISA cycles (trends would be affected if the same practice was not continued), or if there is a good reason for doing so (such as to improve previously poor response rates, differential sampling of certain tracks or programmes is desired, etc.).

Sampling units to be used on school-level frames have been discussed with each country before the Field Trial. Figure 4.4 presents the comments from NPMs, in cases where "school" was not the unit of sampling. Where the Sampling Unit column indicates 'School', this means that the school was the sampling unit. Where it shows 'Other' then something else was used, as described in the comments. Figure 4.4 shows the extent to which countries do not select schools in PISA, but rather something else.

■ Figure 4.4 [Part 1/2] ■

Sampling frame unit

		Sampling unit school / Other	Sampling frame units comment
OECD	Australia	Other	Schools with more than one campus listed as separate entries
	Austria	Other	Either whole schools or programmes within schools
	Belgium	Other	A combination of whole schools (French- and German-speaking communities) and implantations (Tracks/ programmes taught on a single address/location [administrative address]) (Flemish Community)
	Canada	School	
	Chile	Other	Whole schools except in the case of 80 schools, which were each split into two school parts, with one part treated as a school exclusion since it contains only excluded students. The other part corresponds to regular education programmes
	Czech Republic	Other	Basic school - whole school Special and practical school - whole school Gymnasium - pseudo schools according to the length of study (4 year gymnasium and 6 or 8 year gymnasium) Upper secondary vocational - pseudo schools (schools with *maturate*, schools without *maturate*)
	Denmark	School	
	Estonia	School	
	Finland	School	
	France	School	
	Germany	School	Exceptions in SEN schools
	Greece	School	
	Hungary	Other	Tracks in parts of schools on different settlements
	Iceland	School	
	Ireland	School	
	Israel	School	
	Italy	School	
	Japan	Other	Programme
	Korea	School	
	Luxembourg	School	
	Mexico	School	
	Netherlands	Other	Locations of (parts of) schools, often parts of a larger managerial unit
	New Zealand	School	
	Norway	School	
	Poland	School	
	Portugal	School	
	Slovak Republic	School	
	Slovenia	Other	Study program in ISCED3 schools and whole ISCED2 schools
	Spain	Other	Whole school is the option selected for Spain Only in the Basque Country (5% of Spanish population) the same school may be divided into three, each one corresponding to each linguistic model (A, B, D) within the region
	Sweden	School	
	Switzerland	School	
	Turkey	School	
	United Kingdom (excluding Scotland)	School	
	United Kingdom (Scotland)	School	
	United States	School	



■ Figure 4.4 [Part 2/2] ■

Sampling frame unit

		Sampling unit school / Other	Sampling frame units comment
Partners	Albania	School	
	Argentina	Other	Location of schools
	Brazil	School	
	Bulgaria	School	
	Colombia	School	
	Costa Rica	School	
	Croatia	Other	School locations
	Cyprus[1, 2]	School	
	Georgia	School	
	Hong Kong-China	School	
	Indonesia	School	
	Jordan	School	
	Kazakhstan	School	
	Latvia	School	
	Liechtenstein	School	
	Lithuania	School	
	Macao-China	School	
	Malaysia	School	
	Montenegro	School	
	Peru	School	
	Qatar	School	
	Romania	Other	School programmes
	Russian Federation	School	
	Serbia	School	
	Shanghai-China	School	
	Singapore	School	
	Chinese Taipei	School	
	Thailand	School	
	Tunisia	School	
	United Arab Emirates	Other	Separate curricula and also by gender. Whole schools sometimes
	Uruguay	School	
	Viet Nam	School	

1. Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".
2. Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

Notes

1. Students were deemed participants if they gave at least one response to the cognitive assessment, or they responded to at least one student questionnaire item and either they or their parents provided the occupation of a parent or guardian (see Annex G).

2. Technical reference documents are available on the OECD PISA website: *www.oecd.org/pisa*.

3. Technical reference documents are available on the OECD PISA website: *www.oecd.org/pisa*.

4. Note by Turkey: The information in this document with reference to "Cyprus" relates to the southern part of the Island. There is no single authority representing both Turkish and Greek Cypriot people on the Island. Turkey recognises the Turkish Republic of Northern Cyprus (TRNC). Until a lasting and equitable solution is found within the context of the United Nations, Turkey shall preserve its position concerning the "Cyprus issue".

Note by all the European Union Member States of the OECD and the European Union: The Republic of Cyprus is recognised by all members of the United Nations with the exception of Turkey. The information in this document relates to the area under the effective control of the Government of the Republic of Cyprus.

5. These include schools with multiple languages of mathematics instruction, vocational schools, technical schools, agriculture schools, and schools with only part-time students, schools with multiple shifts and so on.

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