2 Implementation of the TIMSS Sampling Design

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2.1 THE TARGET POPULATION

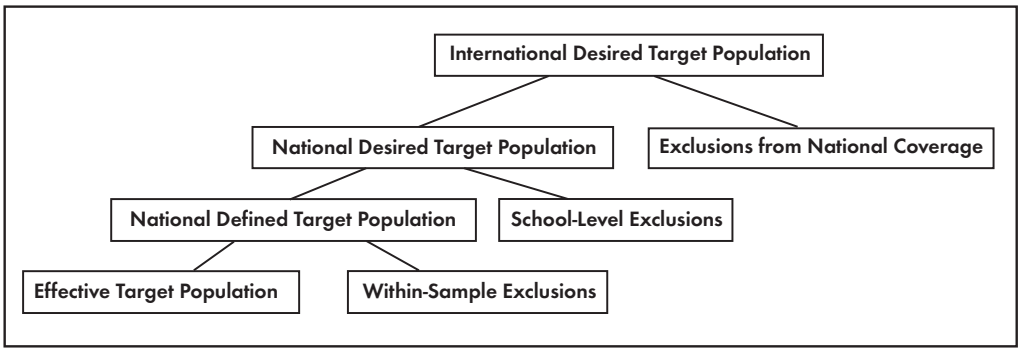
The selection of valid and efficient samples is crucial to the quality and success of an international comparative study such as TIMSS. The accuracy of the survey results depends on the quality of the sampling information available when planning the sample, and on the care with which the sampling activities themselves are conducted. For TIMSS, National Research Coordinators (NRCs) worked on all phases of sampling with staff from Statistics Canada. NRCs were trained in how to select the school and student samples and how to use of the sampling software. In consultation with the TIMSS sampling referee (Keith Rust, Westat), staff from Statistics Canada reviewed the national sampling plans, sampling data, sampling frames, and sample selection. This documentation was used by the International Study Center jointly with Statistics Canada, the sampling referee, and the Technical Advisory Committee to evaluate the quality of the samples.

The assessment of final-year students was intended to measure what might be considered the "yield" of the elementary and secondary education systems of a country with regard to mathematics and science. This was done by assessing the mathematics and science literacy of all students in the final year of secondary school, the advanced mathematics knowledge of students having taken advanced mathematics courses, and the physics knowledge of students having taken physics. The International Desired Population, then, was all students in the final year of secondary school, with those having taken advanced mathematics courses and those having taken physics courses as two overlapping sub-populations. Students repeating the final year were not part of the desired population. For each secondary education track in a country, the final grade of the track was identified as being part of the target population, allowing substantial coverage of students in their final year of schooling. For example, grade 10 could be the final year of a vocational program, and grade 12 the final year of an academic program. Both of these grade/track combinations are considered part of the population (but grade 10 in the academic track is not). Appendix A of Mullis et al. (1998) describes the structure of the upper secondary education systems and the students tested in each country. Appendix B of this volume gives more details of the population definition and sample design for each country.

2.2 COVERAGE OF THE TIMSS TARGET POPULATION

The stated objective in TIMSS was that the effective population, the population actually sampled by TIMSS, be as close as possible to the International Desired Population. Figure 2.1 illustrates the relationship between the desired populations and the excluded populations at the country, school, and student levels.

Figure 2.1 Relationship Between the Desired Populations and Exclusions



Using the International Desired Population as a basis, participating countries had to operationally define their population for sampling purposes. Occasionally, NRCs had to restrict coverage at the country level, for example by excluding remote regions or a segment of the education system. In these few situations, countries were permitted to define a National Desired Population that did not include part of the International Desired Population. Exclusions could be based on geographic areas or language groups. Table 2.1 shows differences in coverage between the International and National Desired Populations. Most participants achieved 100 percent coverage (20 out of 24). The countries with less than 100 percent coverage are footnoted in tables in the international report. Israel and Lithuania, as a matter of practicality, needed to define their tested populations according to the structure of their school systems. Latvia, which participated only in the physics assessment, limited its testing to Latvian-speaking schools. Because coverage fell below 65 percent, the Latvian results have been labeled Latvia (LSS), for Latvian Speaking Schools, in the tables presenting results for the physics assessment. Italy was unable to include 4 of its 20 regions.

Within the National Desired Population, countries could exclude a small percentage – less than 10 percent – of certain kinds of schools or students that would be very difficult or resource-intensive to test, such as schools for students with special needs, or schools that were very small or located in extremely remote areas. Some countries also excluded students in particular tracks or school types. These exclusions are also shown in Table 2.1. The countries with particularly high exclusions are so footnoted in the achievement tables in the report.

Table 2.1 Coverage of TIMSS Target Population

The International Desired Population is defined as follows:
Population 3 – All students in final year of secondary school

Country	International Desired Population		National Desired Population	
	Country Coverage	Notes on Coverage	Sample Exclusions	Notes on Exclusions
Australia	100%		5.5%	
Austria	100%		18.2%	Colleges and courses lasting less than 3 years excluded
Canada	100%		8.9%	
Cyprus	100%		22.0%	Private and vocational schools excluded
Czech Republic	100%		6.0%	
Denmark	100%		2.3%	
France	100%		1.0%	
Germany	100%		11.3%	
Greece	100%		85.0%	Only students having taken advanced mathematics and physics included
Hungary	100%		0.2%	
Iceland	100%		0.1%	
Israel	74%	Hebrew public education system	0.0%	
Italy	70%	Four regions did not participate	0.9%	
Latvia (LSS)	50%	Latvian speaking students	85.0%	Only students having taken physics included
Lithuania	84%	Lithuanian speaking students	0.0%	
Netherlands	100%		21.6%	Apprenticeship programs excluded
New Zealand	100%		0.0%	
Norway	100%		3.8%	
Russian Federation	100%		43.0%	Vocational schools and non-Russian-speaking students excluded
Slovenia	100%		6.0%	
South Africa	100%		0.0%	
Sweden	100%		0.2%	
Switzerland	100%		2.5%	
United States	100%		3.7%	

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Participants could exclude schools from the sampling frame if they were geographically remote, were extremely small, had a curriculum or structure different from the mainstream, or provided instruction only to students in the "within-school" exclusion categories. The general TIMSS rules for defining within-school exclusions follow.

- **Educable mentally disabled students.** These are students who are considered, in the professional opinion of the school principal or other qualified staff members, to be educable mentally disabled students, or who have been so diagnosed in psychological tests. This includes students who are emotionally or mentally unable to follow even the general instructions of the TIMSS test. It does not include students who merely exhibit poor academic performance or discipline problems.

- **Functionally disabled students.** These are students who are permanently physically disabled in such a way that they could not perform in the TIMSS tests. Functionally disabled students who could perform in the TIMSS test were included in the testing.

- **Non-native-language speakers.** These are students who cannot read or speak the language of the test and so could not overcome the language barrier of testing. Typically, students who had received less than one year of instruction in the language of the test were excluded, but this definition was adapted in different countries. Some countries opted to test students in more than one language.

2.3 TIMSS COVERAGE INDEX

Historically, an important difference between education systems was the proportion of an age cohort that successfully completed upper secondary education. In order to avoid unwittingly comparing the elite students in one country with the more general population in another, therefore, it is important to be aware of the extent to which the upper secondary system in each country includes the total student population.

So as to learn how much of the school-leaving age cohort was still in school and represented by the TIMSS sample, a TIMSS Coverage Index (TCI) was computed for each country. The TCI is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year student sample. It reflects any omissions from the sample, such as students who were excluded because of handicap or who had dropped out of school, and, in some countries, tracks or educational programs that were not covered by the TIMSS sample. The TCI was computed by forming a ratio of the size of the student population covered by the TIMSS sample, as estimated from the sample itself, to the size of the school-leaving age cohort, which was derived from official population census figures supplied by each country. The TCI was defined as follows:

$$TCI = \frac{\textit{Total enrollment in TIMSS Grades } 1995}{(\textit{Total national population aged } 15\text{-}19 \textit{ in } 1995)/5}$$

The *numerator* in this expression is the total enrollment in the grades tested by TIMSS, estimated from the weighted sample data. This estimate corresponds to the size of the population to which the TIMSS results generalize, and makes appropriate provision for student non-response. It does not include students who are no longer attending school, or students who were excluded from the sample on grounds of physical or other disability. It also does not include students who were repeating the final grade.

The *denominator* in the expression is an estimate of the school-leaving age cohort size. Since the age at which upper secondary students may leave school varies, TIMSS estimated the size of the school-leaving age cohort by taking the average of the size of the 1995 age cohorts for 15-, 16-, 17-, 18-, and 19-year-olds in each country. (Although the general procedure was to base the estimate on the 15-19 age group, there were exceptions. For example, in Germany, the estimate was based on the 17-19 age group.) This information was provided by National Research Coordinators from official population

census figures in their countries. This approach reflects the fact that students in the final year of secondary school are likely to be almost entirely a subset of the population of 15- to 19-year-olds in most countries.

Table 2.2 Computation of TCI: Estimated Percentage of School-Leaving Age Cohort Covered by TIMSS Sample Final Year of Secondary School

Country	Estimated School-Leaving Age Cohort Size (A)	Estimated Number of Students Represented by Sample (B)	Estimated Number of Students Excluded from Sample (C)	Estimated Number of Other Students Not Represented by Sample (D)	TIMSS Coverage Index (TCI)† (B/A)
Australia	250,852	170,849	9,944	70,059	68%
Austria	93,168	70,721	15,682	6,765	76%
Canada	374,499	263,241	25,559	85,699	70%
Cyprus	9,464	4,535	1,279	3,650	48%
Czech Republic	177,180	137,467	8,821	30,892	78%
Denmark	65,683	37,872	872	26,939	58%
France	760,452	637,935	6,509	116,008	84%
Germany	870,857	655,916	83,514	131,427	75%
[1] Greece	146,400	14,668	83,119	48,613	10%
Hungary	170,524	111,281	201	59,042	65%
Iceland	4,231	2,308	2	1,921	55%
Israel	-	-	-	-	-
Italy	739,268	380,834	3,459	354,975	52%
[2] Latvia (LSS)	33,096	979	5,548	26,569	3%
Lithuania	52,140	22,160	0	29,980	43%
Netherlands	187,087	145,916	40,293	878	78%
New Zealand	53,284	37,549	4	15,731	70%
Norway	52,180	43,806	1,747	6,627	84%
Russian Federation	2,145,918	1,031,187	777,913	336,818	48%
Slovenia	30,354	26,636	1,706	2,012	88%
South Africa	766,334	374,618	0	391,716	49%
Sweden	101,058	71,333	168	29,557	71%
Switzerland	79,547	65,174	1,671	12,702	82%
United States	3,612,800	2,278,564	88,642	1,245,594	63%

† TIMSS Coverage Index (TCI): Estimated percentage of school-leaving age cohort covered by TIMSS sample.

[1] Greece sampled only students having taken advanced mathematics and physics.

[2] Latvia (LSS) sampled only students having taken physics.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

A dash (-) indicates data are not available.

In countries with high TCIs most of the students are still in school and are covered in the TIMSS sample. Countries with low TCIs have fewer students still in school, or have excluded some components of their system from their sample (or both). Table 2.2 presents the TCI for each country, and also shows the two parts of the portion of the school-leaving age cohort not covered by the TIMSS sample: system components and students excluded by the country, and others – primarily young people who chose not to complete upper secondary education. The percentage of the age cohort covered by the TIMSS sample (the TCI), the percentage excluded from the sample, and the percentage of others not covered combine to form 100 percent of the school-leaving age

cohort. For example, Australia has a TCI of 68.1 percent, which indicates that the TIMSS sample of final-year students covers just over two-thirds of the school-leaving age cohort. Of the rest, 4 percent have been excluded from the sample, and the remaining 27.9 percent are presumably no longer attending school. The TCI for Cyprus is lower (47.9 percent), partly because Cyprus excluded students in private schools and in vocational programs (13.5 percent), and partly because a greater percentage of the age cohort is no longer attending school (38.6 percent).

In order to quantify the coverage of the advanced mathematics and physics samples and help interpret the achievement results for these students, TIMSS computed a Mathematics TIMSS Coverage Index (MTCI) and a Physics TIMSS Coverage Index (PTCI), as shown in Table 2.3. The MTCI is the overall TCI multiplied by the percentage of the final-year sample having taken advanced mathematics. For example, in Australia 23.1 percent of the final-year sample had taken advanced mathematics. Multiplying this by the TCI (68.1 percent, from Table 2.2) gives a MTCI of 15.7 percent, as shown in the second column of Table 2.3. This implies that about 16 percent of the school-leaving age cohort in Australia had taken advanced mathematics in upper secondary school. Similarly, the PTCI for Australia is 12.6 percent, as shown in the fourth column of Table 2.3.

Table 2.3 TIMSS Coverage Indices (TCIs) for Advanced Mathematics and Physics Final Year of Secondary School

Country	Percentage of Students in Sample Having Taken Advanced Mathematics	Mathematics TIMSS Coverage Index (MTCI)*	Percentage of Students in Sample Having Taken Physics	Physics TIMSS Coverage Index (PTCI)†
Australia	23.1%	15.7%	18.5%	12.6%
Austria	43.9%	33.3%	43.5%	33.1%
Canada	22.3%	15.6%	19.4%	13.7%
Cyprus	18.5%	8.8%	18.5%	8.8%
Czech Republic	14.1%	11.0%	14.1%	11.0%
Denmark	35.7%	20.6%	5.5%	3.2%
France	23.8%	19.9%	23.8%	19.9%
Germany	34.9%	26.3%	11.2%	8.4%
[1] Greece	-	10.0%	-	10.0%
[2] Israel	-	-	-	-
Italy	27.4%	14.1%	16.7%	8.6%
[3] Latvia	-	-	-	3.0%
Lithuania	6.1%	2.6%	-	-
Norway	-	-	10.0%	8.4%
Russian Federation	4.2%	2.0%	3.2%	1.5%
Slovenia	85.9%	75.4%	43.9%	38.6%
Sweden	23.0%	16.2%	23.1%	16.3%
Switzerland	17.4%	14.3%	17.3%	14.2%
United States	21.8%	13.7%	22.9%	14.5%

* MTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of advanced mathematics students.

† PTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of physics students.

[1] Greece sampled only students having taken advanced mathematics and physics.

[2] The MTCI and the PTCI could not be computed for Israel.

[3] Latvia sampled only students having taken physics.

A dash (-) indicates data are not available.

Note: Hungary, Iceland, the Netherlands, New Zealand, and South Africa did not participate in the advanced mathematics and physics testing. Norway did not participate in the advanced mathematics testing and Lithuania did not participate in the physics testing.

2.4 SAMPLE DESIGN

One of the goals of TIMSS was to assess the mathematics and science literacy of all students while also assessing the advanced mathematics and physics knowledge of students with preparation in these subjects. To that end, a sampling design had to be developed that ensured that students were stratified according to their level of preparation in mathematics and physics, so that appropriate test booklets could be assigned to them. According to the TIMSS design each student is characterized as having taken advanced mathematics (M) or not (O), and as having taken physics (P) or not (O). Combining these two-way classifications yields four mutually exclusive and exhaustive categories of students:

OO Students having studied neither advanced mathematics nor physics

OP Students having studied physics but not advanced mathematics

MO Students having studied advanced mathematics but not physics

MP Students having studied both advanced mathematics and physics

Four kinds of student test booklets were assigned to students on the basis of this classification scheme (OO, OP, MO, MP), so that each student completed one 90-minute booklet. Students classified as OO received either booklet 1A or 1B, the two booklets containing items related to mathematics and science literacy. Students classified as OP received either booklet 1A or 1B, or one of the three booklets containing physics material (2A, 2B, or 2C). Students classified as MO received either booklet 1A or 1B, or one of the three booklets containing advanced mathematics material (3A, 3B, or 3C). Students classified as MP also received one booklet, which could have been any one of the booklets (1A, 1B, 2A, 2B, 2C, 3A, 3B, 3C, or 4). Booklet 4 contained mathematics and science literacy, advanced mathematics, and physics items. The TIMSS test design is described in detail in Adams and Gonzalez (1996).

Table 2.4 Assignment of Test Booklets According to Student Classification

Student Type	Booklet Assigned
OO	1A or 1B
OP	1A, 1B, 2A, 2B or 2C
MO	1A, 1B, 3A, 3B or 3C
MP	1A, 1B, 2A, 2C, 3A, 3B, 3C or 4

The student samples used for estimating the parameters of the three populations of interest (all students in their final year of secondary school, final-year students having taken advanced mathematics, and final-year students having taken physics) were constructed by combining the students who had been assigned the appropriate booklets. Thus, the student sample for estimating proficiency in mathematics and science literacy was made up of all the students from each of the four student groups (OO, OP, MO, and MP) who were assigned one of the literacy booklets (booklets 1A or 1B) or the combined literacy, mathematics, and physics booklet (booklet 4). This ensured that each type of student was properly represented in the final-year sample. The sample for estimating proficiency in advanced mathematics consisted of students from the MO and MP groups who were assigned one of the mathematics booklets (booklets 3A, 3B, or 3C) or the combined literacy, advanced mathematics, and physics booklet (booklet 4). The sample for estimating proficiency in physics consisted of students from the OP and MP groups who were assigned one of the physics booklets (booklets 2A, 2B, or 2C) or the combined literacy, advanced mathematics, and physics booklet (booklet 4).

2.5 REQUIREMENTS FOR SAMPLING PRECISION

The general standards for sampling precision established for TIMSS are discussed in Foy, Rust, and Schleicher (1996). The sampling precision requirement for mathematics and science literacy was a confidence interval of no more than ±0.1 standard deviation units at the 95 percent confidence level. Although efforts were made to ensure the same precision for the advanced mathematics and physics scales, it was recognized that circumstances in participating countries would make this sometimes difficult to achieve. Because of this, TIMSS participants, in consultation with the sampling coordinators, were permitted to design samples for these scales that would achieve confidence intervals of ±0.15 standard deviation units at the 95 percent confidence level.

The sampling design was a two-stage process, with schools sampled with probability-proportional-to-size (PPS) in the first stage, and a fixed number of students sampled in the second stage. To meet the TIMSS standard for sampling precision, approximately 120 schools were required in each country. Within each sampled school, students were classified OO, OP, MO, MP, and 40 students sampled at random, 10 from each category. Because the organization of school systems at upper secondary level varies considerably across countries, each country had to work with the sampling consultants to adapt the basic design to the local situation.

The basic design was well suited to comprehensive systems, where schools cater to all kinds of students, and students must be classified individually or on the basis of the courses they have taken. However, many of the TIMSS countries operate tracked systems, where students are assigned to particular types of schools on the basis of their academic interests and abilities. In such countries it was often possible to stratify whole schools in terms of whether or not they contained advanced mathematics or physics classes. In such systems it was sometimes possible to refine the basic design so as to achieve the required sampling precision with a smaller sample of schools. Although there was no analytic requirement to sample students in whole classes rather than individually, some countries found it more convenient to do so, even though the increased clustering effect sometimes necessitated larger sample sizes.

2.6 SCHOOL SAMPLING

The sample-selection method used for first-stage sampling was based on a systematic probability-proportional-to-size technique. Countries were encouraged to stratify schools by important demographic variables (e.g., geographical region, public/private) as well as by school type. Small schools were handled either by assigning them to separate strata or by combining them with larger schools to form pseudo-schools for sampling purposes. Some very large countries introduced a preliminary sample stage before schools were sampled, in which the country was divided into primary sampling units. Within each stratum, schools were listed in order of any implicit stratification variables, and then further sorted according to their measure of size. Schools were then sampled using a random-start fixed-interval procedure that ensured selection with probability-proportional-to-size.

Sometimes a sampled school was unable to participate in the assessment. In such cases, it was replaced by a *replacement school*. The mechanism for selecting replacement schools, established a priori, identified the next school on the ordered school-sampling list as the replacement for each sampled school, and the one after that as a second replacement, should it be necessary. Since schools were grouped by stratification variables and by size on the sampling frame, a replacement school should have characteristics similar to the originally selected school.

2.7 STUDENT SAMPLING

Whereas schools were sampled with probability- proportional-to-size, the basic design called for a fixed number of students to be sampled within each school in the second stage of sampling. This gives selection probabilities for students that are inversely proportional to school size. The combined school and student selection probabilities result in an overall selection probability that is equal for all students in each explicit stratum. In untracked schools, students were classified into one of the four groups (OO, OP, MO, MP), and a sample of 10 students was drawn from each group. If just three student types were present (for example if there were no OP students, as sometimes happened) three samples of 13 students were drawn. In schools with no advanced mathematics or physics students, all 40 students were sampled from the OO group. In some tracked systems, schools frequently consisted either of only OO students or of only MP students. In these situations all 40 students were sampled from the appropriate group. Detailed procedures for sampling students were specified within schools for a variety of school organizations. These procedures are presented in Schleicher and Siniscalco (1996).

2.8 PARTICIPATION RATES

Weighted and unweighted participation rates were computed for each participating country, at the school level and at the student level for each assessment (mathematics and science literacy, advanced mathematics, and physics). Overall response rates (combined school and student response rates) also were computed for each assessment.

2.8.1 School-Level Participation Rates

The general formula for computing weighted school-level participation rates is shown in the following equation:

$$R_{wgt}(sch) = \frac{\sum_{part} MOS_i/\pi_i}{\sum_{elig} MOS_i/\pi_i}$$

For each sampled school, the ratio of its measure of size (MOS) to its selection probability (π_i) was computed. The weighted school-level response rate is the sum of the ratios for all participating schools divided by the sum of the ratios for all eligible schools. The unweighted school-level response rates were computed in a similar way, where all school ratios were set to one. This becomes simply the number of participating schools in the sample divided by the number of eligible schools in the sample. Since in most cases, in selecting the sample, the value of π_i was set proportional to MOS_i within each explicit stratum, weighted and unweighted rates were generally similar.

2.8.2 Student-Level Participation Rates

The general formula for computing student-level participation rates is shown in the following equation:

$$R_{wgt}(stu) = \frac{\sum_{part} 1/p_j}{\sum_{elig} 1/p_j}$$

where p_j denotes the probability of selection of the student, incorporating all stages of selection. Thus the weighted student-level participation rate is the sum of the inverse of the selection probabilities for all participating students divided by the sum of the inverse of the selection probabilities for all eligible students. The unweighted student participation rates were computed in a similar way, but with each student contributing equal weight.

2.8.3 Overall Participation Rates

The overall participation rate was calculated as the product of the weighted school-level participation rate without replacement schools and the weighted student-level participation rate. School and student sample sizes and participation rates are presented in Tables 2.5 to 2.11.

Table 2.5 School Sample Sizes – Mathematics and Science Literacy Final Year of Secondary School

Country	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	132	132	71	16	87
Austria	182	182	74	95	169
Canada	389	389	333	4	337
Cyprus	29	28	28	0	28
Czech Republic	150	150	150	0	150
Denmark	130	130	122	0	122
France	71	71	56	0	56
Germany	174	174	121	31	152
Hungary	204	204	204	0	204
Iceland	30	30	30	0	30
Israel	125	125	52	0	52
Italy	150	150	93	8	101
Lithuania	168	142	142	0	142
Netherlands	141	141	52	27	79
New Zealand	79	79	68	11	79
Norway	171	171	122	9	131
Russian Federation	175	165	159	4	163
Slovenia	172	172	79	0	79
South Africa	185	140	90	0	90
Sweden	157	157	145	0	145
Switzerland	401	401	378	5	383
United States	250	250	190	21	211

Table 2.6 School Sample Sizes – Advanced Mathematics Final Year of Secondary School

Country	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	132	132	68	15	83
Austria	182	119	48	66	114
Canada	389	389	306	3	309
Cyprus	29	21	21	0	21
Czech Republic	90	90	90	0	90
Denmark	130	130	115	0	115
France	69	69	61	0	61
Germany	76	76	53	23	76
Greece	60	60	45	15	60
Israel	125	125	44	0	44
Italy	59	59	41	1	42
Lithuania	29	29	29	0	29
Russian Federation	132	117	112	1	113
Slovenia	172	159	73	0	73
Sweden	157	157	101	0	101
Switzerland	198	198	195	2	197
United States	250	250	180	19	199

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 2.7 School Sample Sizes – Physics Final Year of Secondary School

Country	Number of Schools in Original Sample	Number of Eligible Schools in Original Sample	Number of Schools in Original Sample That Participated	Number of Replacement Schools That Participated	Total Number of Schools That Participated
Australia	132	132	69	16	85
Austria	182	119	48	66	114
Canada	389	389	304	3	307
Cyprus	29	21	21	0	21
Czech Republic	90	90	90	0	90
Denmark	130	130	77	0	77
France	69	69	61	0	61
Germany	74	74	52	22	74
Greece	60	60	45	15	60
Israel	125	125	46	0	46
Italy	29	29	20	0	20
Latvia (LSS)	45	45	38	0	38
Norway	70	70	63	3	66
Russian Federation	132	98	83	1	84
Slovenia	172	172	52	0	52
Sweden	157	157	101	0	101
Switzerland	198	198	195	2	197
United States	250	250	184	19	203

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 2.8 Student Sample Sizes
Final Year of Secondary School

Country	Number of Students Sampled in Participating Schools	Number of Students Withdrawn†	Number of Students Excluded	Number of Students Eligible	Number of Students Absent
Australia	4130	37	0	4093	1040
Austria	3693	140	0	3553	398
Canada	11782	732	0	11050	1470
Cyprus	1224	15	0	1209	38
Czech Republic	4188	43	0	4145	326
Denmark	5208	0	0	5208	672
France	4096	275	0	3821	600
Germany	6971	94	117	6760	1666
Greece	1246	261	0	985	180
Hungary	5493	265	0	5228	137
Iceland	2500	132	2	2366	663
Israel	2568	0	0	2568	29
Italy	2426	148	3	2275	192
Latvia (LSS)	780	6	0	774	66
Lithuania	4196	1	0	4195	574
Netherlands	1882	181	20	1681	211
New Zealand	2687	580	1	2106	343
Norway	4056	76	65	3915	349
Russian Federation	5356	536	0	4820	182
Slovenia	3755	37	1	3717	282
South Africa	3695	906	0	2789	32
Sweden	5362	184	12	5166	589
Switzerland	5939	258	0	5681	262
United States	14812	603	293	13916	3082

† Sampled students who reported that they were repeating the final year, were incorrectly classified, or were otherwise ineligible.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table 2.9 Participation Rates – Mathematics and Science Literacy Final Year of Secondary School

Country	School Participation		Student Participation (Weighted Percentage)	Overall Participation	
	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)		Overall Participation Before Replacement (Weighted Percentage)	Overall Participation After Replacement (Weighted Percentage)
Australia	48.8	66.2	78.1	38.1	51.8
Austria	35.9	90.9	79.7	28.6	72.5
Canada	82.2	82.6	82.7	68.0	68.3
Cyprus	100.0	100.0	98.2	98.2	98.2
Czech Republic	100.0	100.0	92.2	92.2	92.2
Denmark	54.9	54.9	88.9	48.8	48.8
France	80.3	80.3	85.6	68.7	68.7
Germany	88.7	100.0	80.1	71.0	80.1
Hungary	100.0	100.0	97.7	97.7	97.7
Iceland	100.0	100.0	73.6	73.6	73.6
Israel	48.8 **	48.8 **	98.3 **	48.0 **	48.0 **
Italy	59.9	65.0	94.8	56.8	61.6
Lithuania	97.1	97.1	87.9	85.4	85.4
Netherlands	35.8	56.3	87.6	31.3	49.3
New Zealand	87.0	100.0	80.6	70.1	80.6
Norway	74.1	80.0	88.9	65.9	71.1
Russian Federation	93.0	99.3	90.9	84.6	90.3
Slovenia	45.6	45.6	92.8	42.3	42.3
South Africa	65.0	65.0	99.4	64.6	64.6
Sweden	95.3	95.3	86.5	82.4	82.4
Switzerland	87.0	89.1	95.0	82.6	84.6
United States	77.1	85.1	74.6	57.6	63.5

** Unweighted participation rates.

Table 2.10 Participation Rates – Advanced Mathematics Final Year of Secondary School

Country	School Participation		Student Participation (Weighted Percentage)	Overall Participation	
	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)		Overall Participation Before Replacement (Weighted Percentage)	Overall Participation After Replacement (Weighted Percentage)
Australia	47.3	63.6	86.7	40.9	55.2
Austria	36.7	95.5	84.6	31.0	80.8
Canada	84.6	85.2	90.4	76.4	76.9
Cyprus	100.0	100.0	96.0	96.0	96.0
Czech Republic	100.0	100.0	92.1	92.1	92.1
Denmark	54.9	54.9	89.2	49.0	49.0
France	89.9	89.9	86.1	77.4	77.4
Germany	78.6	100.0	77.6	61.0	77.6
Greece	76.2	100.0	86.5	65.9	86.5
Israel	48.8 **	48.8 **	99.6 **	48.6 **	48.6 **
Italy	70.3	70.9	95.1	66.9	67.5
Lithuania	100.0	100.0	92.1	92.1	92.1
Russian Federation	97.6	99.4	96.5	94.2	95.9
Slovenia	45.6	45.6	93.0	42.4	42.4
Sweden	95.3	95.3	92.9	88.6	88.6
Switzerland	99.0	99.0	88.2	87.4	87.4
United States	75.7	84.7	79.6	60.2	67.4

** Unweighted participation rates.

Table 2.11 Participation Rates – Physics Final Year of Secondary School

Country	School Participation		Student Participation (Weighted Percentage)	Overall Participation	
	School Participation Before Replacement (Weighted Percentage)	School Participation After Replacement (Weighted Percentage)		Overall Participation Before Replacement (Weighted Percentage)	Overall Participation After Replacement (Weighted Percentage)
Australia	63.2	63.9	84.9	53.7	54.2
Austria	36.7	95.5	84.6	31.0	80.8
Canada	79.7	80.2	91.0	72.6	73.0
Cyprus	100.0	100.0	96.0	96.0	96.0
Czech Republic	100.0	100.0	92.1	92.1	92.1
Denmark	54.9	54.9	86.1	47.3	47.3
France	89.9	89.9	86.1	77.4	77.4
Germany	76.8	100.0	81.7	62.7	81.7
Greece	76.2	100.0	86.5	65.9	86.5
Israel	48.8 **	48.8 **	99.6 **	48.6 **	48.6 **
Italy	69.3	69.3	96.6	67.0	67.0
Latvia (LSS)	84.4	84.4	90.8	76.6	76.6
Norway	77.7	94.3	88.0	68.4	83.0
Russian Federation	97.6	98.8	96.2	93.9	95.1
Slovenia	45.6	45.6	94.2	43.0	43.0
Sweden	95.3	95.3	92.9	88.6	88.6
Switzerland	99.0	99.0	88.2	87.4	87.4
United States	77.0	84.3	80.3	61.8	67.7

** Unweighted participation rates.

Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

2.9 COMPLIANCE WITH SAMPLING GUIDELINES

Figures 2.2, 2.3, and 2.4 show how countries have been grouped in tables reporting achievement results for mathematics and science literacy, advanced mathematics, and physics, respectively. Countries that complied with the TIMSS guidelines for school and student sampling, and that achieved acceptable participation rates – 85 percent of both the schools and students, or a combined rate (the product of school and student participation) of 75 percent – with or without replacement schools, are shown in the first panel. Countries that met the guidelines only after including replacement schools are so noted.

Countries that did not reach at least 50 percent school participation without the use of replacements schools, or that failed to reach the sampling participation standard even with their use, are shown in the second panel of Figures 2.2 - 2.4. Countries that did not meet the guidelines for student sampling are shown in the third panel, and countries that met neither these requirements nor participation rate requirements are shown in the bottom panel. Unweighted results only are included for Israel[1] because Israel had difficulties meeting several sampling guidelines.

[1] This is effectively implemented by assigning a weight of 1 to all students in the sample for Israel.

Figure 2.2 Countries Grouped for Reporting Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates Mathematics and Science Literacy - Final Year of Secondary School

Countries satisfying guidelines for sample participation rates and sampling procedures	
[2] Cyprus	[†] New Zealand
Czech Republic	[2] Russian Federation
Hungary	Sweden
[1] Lithuania	Switzerland
Countries not satisfying guidelines for sample participation rates	
Australia	Iceland
[2] Austria	[1] Italy
Canada	Norway
France	United States
Countries with unapproved student sampling	
[†] Germany	
Countries with unapproved sampling procedures and low participation rates	
Denmark	Slovenia
[2] Netherlands	South Africa

[†] Met guidelines for sample participation rates only after replacement schools were included.
[1] National Desired Population does not cover all of International Desired Population.
[2] National Defined Population covers less than 90 percent of National Desired Population.

Figure 2.3 Countries Grouped for Reporting Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates Advanced Mathematics – Final Year of Secondary School

Countries satisfying guidelines for sample participation rates and sampling procedures	
Canada	† Greece
[2] Cyprus	[1] Lithuania
Czech Republic	[2] Russian Federation
France	Sweden
† Germany	Switzerland
Countries not satisfying guidelines for sample participation rates	
Australia	[1] Italy
[2] Austria	United States
Countries with unapproved sampling procedures and low participation rates	
Denmark	Slovenia

† Met guidelines for sample participation rates only after replacement schools were included.
[1] National Desired Population does not cover all of International Desired Population.
[2] National Defined Population covers less than 90 percent of National Desired Population.

Figure 2.4 Countries Grouped for Reporting Achievement According to Their Compliance with Guidelines for Sample Implementation and Participation Rates Physics – Final Year of Secondary School

Countries satisfying guidelines for sample participation rates and sampling procedures	
Canada	[1] Latvia (LSS)
[2] Cyprus	[†] Norway
Czech Republic	[2] Russian Federation
France	Sweden
[†] Germany	Switzerland
[†] Greece	
Countries not satisfying guidelines for sample participation rates	
Australia	United States
[2] Austria	
Countries with unapproved sampling procedures and low participation rates	
Denmark	Slovenia

[†] Met guidelines for sample participation rates only after replacement schools were included.
[1] National Desired Population does not cover all of International Desired Population.
[2] National Defined Population covers less than 90 percent of National Desired Population.

2.10 SAMPLING WEIGHTS

Appropriate estimation of population characteristics based on the TIMSS samples requires that the TIMSS sample design be taken into account in all analyses. This is accomplished in part by assigning a weight[2] to each respondent, where the sampling weight properly accounts for the sample design, takes into account any stratification or disproportional sampling of subgroups, and includes adjustments for non-response.[3]

The students within each country were selected using probability sampling. A consequence of this is that each student had a known probability of selection. The inverse of this selection probability is the sampling weight. In a properly selected and weighted sample, the sum of the weights for the sample approximates the size of the population. In TIMSS, the sum of the sampling weights for a country sample is an estimate of the size of the population of students within the country in the sampled grade(s). The sampling weights must be used whenever population estimates are required. The use of

[2] The computation of sampling weights is described in Chapter 4.

[3] Sampling weights can be computed only when the probability of selection is known for all students.

the appropriate sampling weights ensures that the subgroups that constitute the sample are properly and proportionally represented in the computation of population estimates.

Tables 2.12 presents the sample sizes and the estimate of the population size (sum of the weights) for the entire final-year sample, for advanced mathematics students, and for physics students, respectively, for each participating country.

Table 2.12 Sample Information

Country	Students in their Final Year of Secondary School		Students Having Taken Advanced Mathematics		Students Having Taken Physics	
	Sample Size	Estimated Population Size	Sample Size	Estimated Population Size	Sample Size	Estimated Population Size
Australia	1941	170847	645	39498	661	31619
Austria	1962	70602	782	31063	777	30795
Canada	5232	263241	2781	58606	2367	51179
Cyprus	534	4556	391	837	368	837
Czech Republic	2167	137459	1101	19446	1087	19428
Denmark	2714	37872	1388	13527	654	2073
France	1590	637935	1071	151531	1110	151531
Germany	2289	967705	2296	262789	723	87888
Greece	-	-	456	14620	459	14668
Hungary	5091	111281	-	-	-	-
Iceland	1703	2308	-	-	-	-
Italy	1616	380834	398	104477		
Latvia (LSS)	-	-	-	-	708	979
Lithuania	2887	22161	734	1360	-	-
Netherlands	1470	145916	-	-	-	-
New Zealand	1763	37549	-	-	-	-
Norway	2518	43806	-	-	1048	4369
Russian Federation	2289	1031187	1638	42858	1233	32975
Slovenia	1622	26644	1536	22881	747	11706
South Africa	2757	374618	-	-	-	-
Sweden	3068	71243	1001	16408	1012	16459
Switzerland	3308	65140	1404	11343	1371	11276
United States	5807	2278258	2785	496852	3114	522784

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