Appendices

Appendix A

Structure of Upper Secondary Education Systems and Characteristics of Students Tested

The countries participating in TIMSS vary greatly with respect to the nature of their upper secondary education systems. Some countries provide comprehensive education to students in their final years of schools, while other countries are highly tracked and students attend either academic, vocational, or technical schools. Some countries fall in the middle of these extremes where students are enrolled in academic, vocational, or technical programs of study within schools. Across countries there are also varying definitions of academic, vocational, and technical programs and the kind of education and training students in these programs receive.

There also are variations across and within countries with respect to the grades representing the final year of schooling for students. In some countries, all students in their final year of schooling are in the same grade (e.g., secondary schooling ends for all students in Grade 12). In other countries, determining the final year of schooling is much more complicated because there are one or more academic tracks, one or more vocational tracks, and apprenticeship programs. In these countries, the final year of schooling may vary by track, with some students completing secondary school after a two-, three-, or four-year upper secondary program, depending on the type of school or program of study. Furthermore, for vocational programs it is not always straightforward as to when schooling is completed.

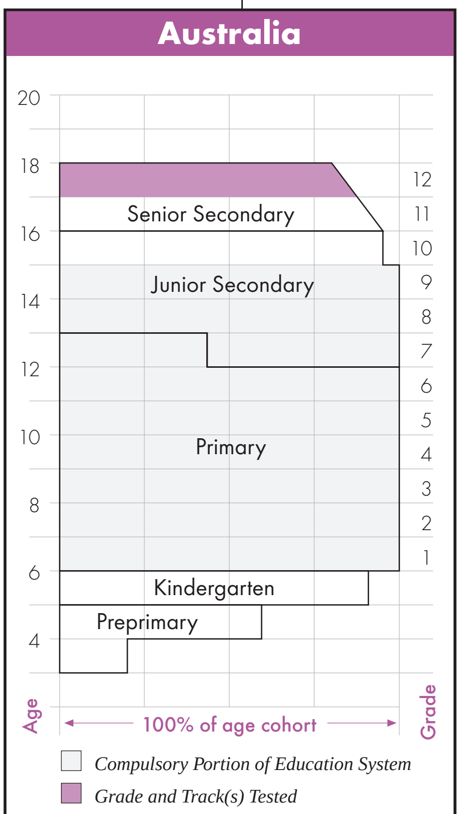
In order to make valid comparisons of the performance of students across countries in mathematics and science literacy, advanced mathematics, and physics, it is critical that there be an understanding of which students were tested in each country, that is, how each country defined the target population. It also is important to understand how each upper-secondary education system is structured and how the tested students fit into the system as a whole. In order to provide a context with which to interpret the achievement results presented in this report, this appendix contains a summary, provided by the National Research Coordinator of each country, describing the structure of the upper secondary system and specifying the grades and tracks (programs of study) in which students were tested for TIMSS. Additional information about the education systems can be found in *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.*[1]

[1] Robitaille D.F. (Ed.) (1997). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS.* Vancouver, B.C.: Pacific Educational Press.

Australia

Structure of Upper Secondary System

School education is the responsibility of the individual states and territories in Australia. Secondary education is provided for either five or six years depending on the length of primary education in the state. Australia's secondary schools provide a comprehensive education, although students can focus on academic/pre-university studies, including humanities and art, mathematics and science, commerce, and other disciplines, or they can focus on vocationally oriented studies.



Students Tested in Mathematics and Science Literacy

Australia tested students in the final year of secondary school, Grade 12, in government, Catholic, and independent schools.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in the final year of secondary school, Grade 12, enrolled in mathematics courses (varies across states) preparing them for postsecondary study, and students in Grade 12 who took such mathematics courses during Grade 11.

Physics: students in the final year of secondary school, Grade 12, enrolled in Year 12 physics.

Austria

Structure of Upper Secondary System

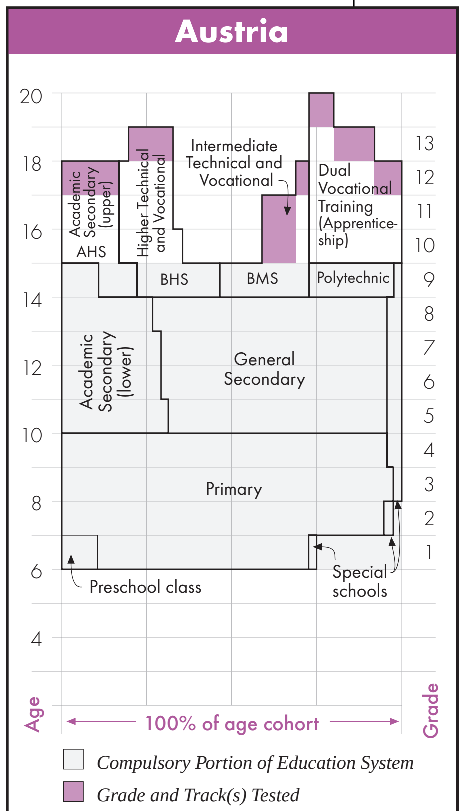
Academic and vocational schools form the upper secondary schooling in Austria. Academic secondary school (AHS) is a four-year cycle of pre-academic general education. Students may specialize in certain areas, but generally study a whole range of subjects. At the end of the cycle, students take a matriculation examination (*Matura*) which, upon passing, enables them to enter university.

There are three variations of vocational schools in Austria. Higher-technical and vocational (BHS) is a five-year cycle in which students study a similar academic curriculum to that in the AHS, but also study theoretical subjects relevant to future professions. Students train for careers in industry, trade, business, agriculture, or

Austria (cont.)

human service occupations. The final examination is similar to the AHS *Matura* and enables students to continue to university or obtain certain levels of vocational qualification. The final year of this cycle is Grade 13.

Intermediate-technical and vocational schools (BMS) are basically full-time schools equivalent to the dual system of school and apprenticeship (see below). These schools provide training in apprenticed trades and general education. The cycle is one to four years, but typically lasts three to four years. Successful completion results in vocational licenses which are sometimes more extensive than the ones given by the dual system. There are also higher teacher training colleges that represent an alternative route from the ninth year (grade) onwards.



In the system of dual vocational education – Apprenticeship/*Berufsschulen* (BS) – apprentices in business and industry receive practical vocational training at their place of work and also attend part-time vocational schools, *Berufsschulen*. Students typically attend the *Berufsschule* one day a week where some element of general education is included. The length of the course is from two to four years, but is three years for most students. The vocational qualification licenses the recipient to work in a legally defined trade.

Students Tested in Mathematics and Science Literacy

Austria tested students in their final year of academic schools (AHS), Grade 12, their final year of higher technical and vocational (BHS), Grade 13, and their final year of medium technical and vocational (BMS), Grades 10, 11, or 12, depending on the vocational program of the student, and students in their final year of the apprenticeship (BS).

Students Tested in Advanced Mathematics and Physics

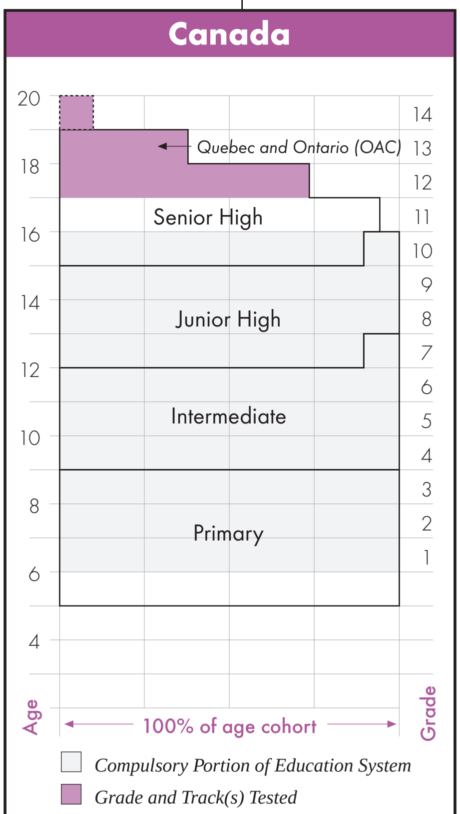
Advanced Mathematics: students in their final year of the academic or higher technical track, taking courses in advanced mathematics.

Physics: students in their final year of the academic or higher technical track, taking courses in physics.

Canada

Structure of Upper Secondary System

Secondary education in Canada is comprehensive, although students can focus on academic/pre-university studies or vocationally oriented studies. The first years of secondary school are devoted to compulsory subjects, with some optional subjects included. In the latter years, the number of compulsory subjects is reduced, permitting students to spend more time on specialized programs that prepare them for the job market, or to take specific courses they need to meet the entrance requirements of the college or university of their choice. Senior high school ends in Grade 12 in all provinces except Quebec, where it ends in Grade 11. In Ontario, some students complete secondary schooling at the end of Grade 12, whereas others continue for an extra year to complete the Ontario Academic Credits (OAC) necessary for admission to university. Students in Quebec continue from Grade 11 to either a two- or three-year training program prior to entry into tertiary education or the workplace.



Students Tested in Mathematics and Science Literacy

Canada tested students in Grade 12 in all provinces except Quebec where students in Grades 13 and 14 (depending on program) were tested. In Ontario, students completing the OAC in Grade 13 also were tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year in mathematics courses preparing them for postsecondary study (varies by province), except in Quebec where students in the two-year science program were tested.

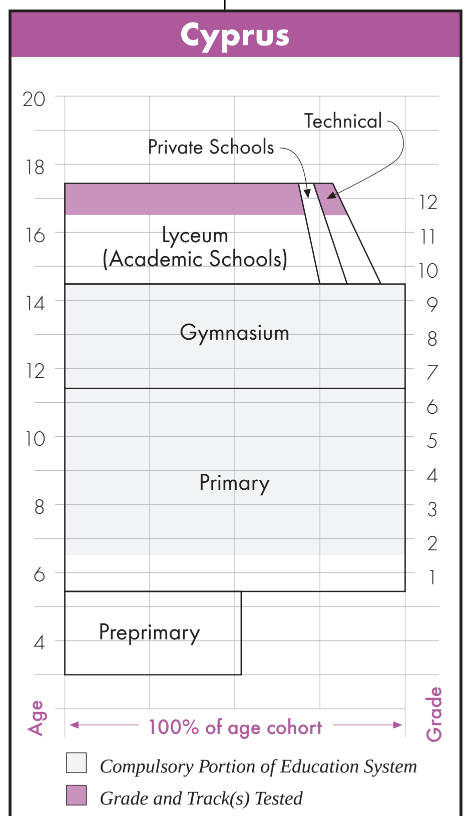
Physics: students in their final year in physics courses preparing them for postsecondary study (varies by province), except in Quebec where students in the two-year science program were tested.

CYPRUS

Structure of Upper Secondary System

Academic schools (lycea) and technical schools form the upper secondary schooling in Cyprus. At the lyceum, which comprises Grades 10, 11, and 12, students can choose one of five groups of subjects – classical (arts), mathematics and science, economics, commercial/secretarial, and foreign languages.

In technical schools, also three years in duration, students can take technical courses with particular emphasis on mathematics and science. Graduates of these programs typically follow further studies in colleges or universities. Technical schools also offer vocational programs in which students in the final year follow a training program in industry for two days a week and attend school for three days a week. In the vocational section, more emphasis is given to practical skills. The aim of public technical schools is to provide industry with technicians and craftsmen in various specializations such as mechanical and automobile engineering, computers, electronics, building, graphic arts, dress-making, gold smithery, shoe manufacturing, and many others. Cyprus' private secondary schools are oriented towards commercial and vocational education and last for six years.



Students Tested in Mathematics and Science Literacy

Cyprus tested students in Grade 12 of lycea and the technical schools. Vocational students in technical schools were not tested. Students in the private vocational schools were not included.

Students Tested in Advanced Mathematics and Physics

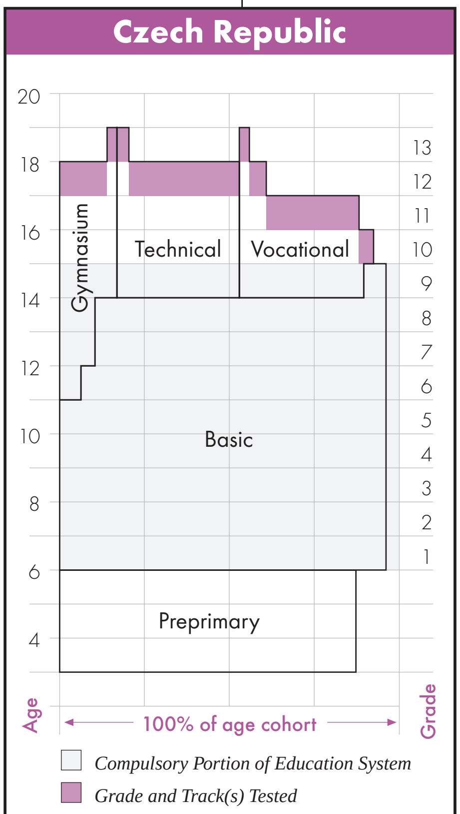
Advanced Mathematics: students in their final year in the mathematics/science program of study at the lyceum.

Physics: students in their final year in the mathematics/science program of study at the lyceum.

Czech Republic

Structure of Upper Secondary System

There are three types of secondary schools in the Czech Republic: gymnasium, technical, and vocational. The gymnasium is a four-, six-, or eight-year general secondary school providing demanding academic training for higher education. Students are in one of three streams in the gymnasium: humanities, science, or general education. Secondary technical schools, four or five years in duration, provide a broad general education as well as specialized study in a particular field (e.g., nursing, certain technical areas, tourism, library science, accounting, etc.). Students successfully completing the gymnasium or secondary technical school, and passing the final examination (maturita), are eligible to apply to institutions of higher education. Secondary vocational schools, two, three, four, or five years in duration, provide practical vocational training as well as general education, with the aim to prepare students for occupations. These professional schools specialize mostly in engineering and technical areas.



Secondary schooling ends in different years depending on the type of school and the course of study within school. In almost all secondary technical school and gymnasia, students complete their education at the end of Grade 12, although a few complete their studies in Grade 13. In vocational schools, students may end in Grades 10, 11, 12, or 13, depending on their type of vocation.

Since the time of the TIMSS testing (1995), the Czech system has been modified to reflect an extension of basic school. Beginning in 1996, Grade 9 became compulsory (until this decision was made, Grade 9 was an optional grade, attended by 14% of the age cohort in 1993/94). It means that currently all secondary technical and gymnasia students complete their education in Grade 13 and most vocational students complete their studies in Grade 12.

Students Tested in Mathematics and Science Literacy

The Czech Republic tested students in their final year of each type of school. In technical schools and gymnasia, students in Grades 12 and 13 were tested. In vocational schools, students in Grades 10, 11, 12, and 13 were tested, depending on their vocation.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: gymnasium students in their final year of study, Grade 12 or 13.

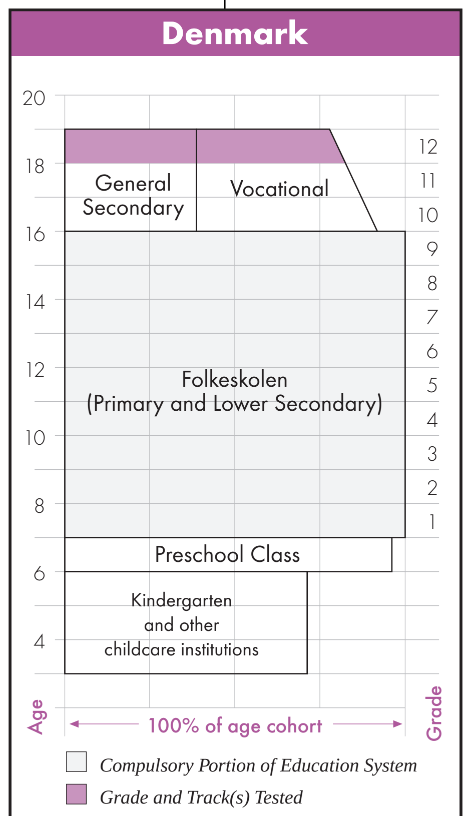
Physics: gymnasium students in their final year of study, Grade 12 or 13.

Denmark

Structure of Upper Secondary System

The general upper secondary programs are comprised of the general upper secondary certificates (*Studentereksamen*), the higher preparatory exam (HF) for mature students, the higher commercial exam (HHX), and the higher technical exam (HTX). The first two programs are taught at the Gymnasium and the last two at commercial and technical schools, respectively. All programs have a duration of three years except for the HF which is two years. The aim of the first two programs is primarily to prepare students for further studies at the tertiary level. The HHX and HTX prepare pupils for higher education but qualify also as final vocational education.

Vocational upper secondary programs encompass approximately 100 different specializations including vocational education and training, training for social affairs and health officers, agricultural education, and maritime education. Vocational training in Denmark is rooted in the apprenticeship tradition, but a wide-ranging modernization has been carried out over the past 30 years. This modernization has taken into account the lack of capacity among small and medium-sized enterprises to organize and carry out such training and reflects the need for a continuous updating of such programs.



Students Tested in Mathematics and Science Literacy

Denmark tested students in Grade 12 of the general secondary and vocational schools. Students finishing their formal schooling after Folkeskole (Grade 9) were not tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: mathematics and physics students in the gymnasium and mathematics students in their final year, Grade 12, of the technical or higher preparation tracks.

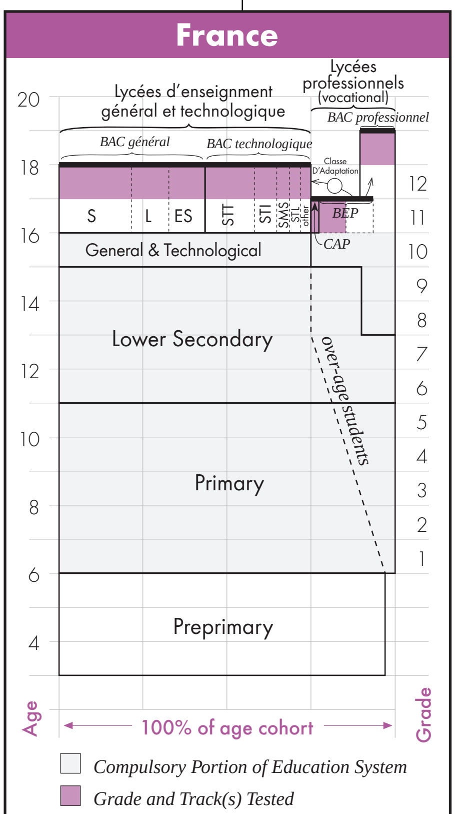
Physics: mathematics and physics students in the gymnasium and physics students in their final year, Grade 12, of the technical track.

France

Structure of Upper Secondary System

There are two types of upper secondary schools in France: *lycées d'enseignement général et technologique*, or upper secondary school for Grades 10 to 12, and *lycées professionnels* or vocational upper secondary school, which may end at Grade 11 or Grade 13.

In the *lycée d'enseignement général et technologique*, students in Grades 10, 11, and 12 are in either the general track or the technological track. In Grade 10, there are both common areas of study and optional courses in the general and technological tracks. All students at this level take mathematics and science courses. In Grade 11, the different tracks are strongly differentiated, leading to corresponding types of *baccalauréats*. The *baccalauréat général* has three main tracks: scientific (S), literary (L), and economic and social (ES). The *baccalauréat technologique* has four major tracks within it: tertiary sciences and technologies (STT), industrial sciences and technologies (STI), medical-social sciences (SMS), and laboratory sciences and technologies (STL). The type and amount of mathematics and science taken by *lycée* students is different for each of the tracks within the general and technological tracks. The final year of the general and technological tracks is Grade 12.



Vocational Grade 10 is the first year of a program leading to the *Brevet d'études professionnelles* (BEP) or to the *Certificat d'aptitude professionnelle* (CAP). Most pupils achieve a *Brevet d'études professionnelles*, which is granted after Grade 11. About 50 percent of students achieving this diploma decide to continue their studies, either by joining the technological track through a *classe d'adaptation* or by continuing in vocational secondary for an additional two years to achieve the *baccalauréat professionnel*. Their choice depends mainly on their results, but also on the area of their studies and employment prospects with a *Brevet d'études professionnelles*. The *baccalauréat* leads directly to university studies. The final year for a student in the *lycée professionnel* is either Grade 11 or Grade 13, depending on whether or not they plan to continue their studies.

Note: Compulsory schooling goes from the age of 6 until the age of 16. With some students repeating some classes, the correspondence between age and grade becomes theoretical.

France (cont.)

Students Tested in Mathematics and Science Literacy

France tested students in the final year of preparation for the *baccalauréat* (nonrepeaters of this final year). This included students in Grade 12 preparing for the *baccalauréat général ou technologique*, and in Grade 13 for the *baccalauréat professionnel* (vocational). Also tested were students in the final year (nonrepeaters of this year) of preparation for the *Brevet d'études professionnelles* (BEP) or the *Certificat d'aptitude professionnelle* (CAP) who will not continue towards a *baccalauréat.*

Students Tested in Advanced Mathematics and Physics

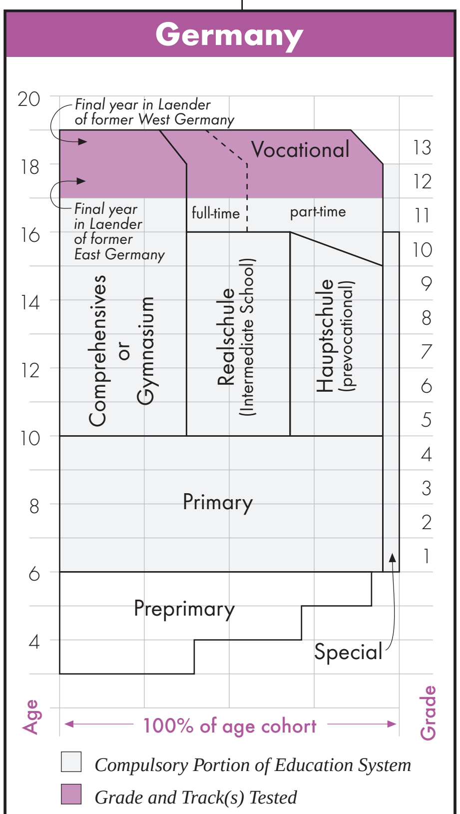
Advanced Mathematics: students in their final year of the scientific track, Grade 12, preparing for the *baccalauréat général.*

Physics: students in their final year of the scientific track, Grade 12, preparing for the *baccalauréat général.*

Germany

Structure of Upper Secondary System

The upper secondary education system, Grades 11 to 13, in Germany is comprised of two types of schools – gymnasia or comprehensive schools and vocational schools. Education is compulsory up to age 18. In the upper grades of gymnasium, beginning in Grade 11, students can choose specializations within a rather complicated framework that allocates approximately one-third of instruction time to languages and arts, one-fourth to social studies (civic education, history, religion or philosophy), one-third to mathematics and science, and one-twelfth to sports. Upon successful completion of the final examination at the end of Grade 12 or 13 (final year depends on the Laender) a student may attend university.



Those students interested in vocational training have a variety of options. A dual system combines general education and theoretical instruction in the specific area of occupational training in part-time schools (*Berufsschule*), and practical training in one of over 500,000 authorized companies or businesses (*Betriebe*). Usually students in the dual system attend school two days a week and work the other three days at a company in a training program. At the company, students are supervised and taught by accredited trainers according to the training regulations in effect pertaining to the occupation. In larger companies, students often receive additional instruction in company schools. There is also a broad range of full-time vocational schools, such as *Fachgymnasien*, where students are instructed in economic and technical fields and admission requirements for university-level studies are fulfilled. Other types of schools are *Fachoberschulen* that certify for further specialized scientific training at institutions of higher education as well as *Berufsfachschulen* that provide occupational training for careers in social and health services and business.

Students Tested in Mathematics and Science Literacy

Germany tested students in their final year in the academic track of upper secondary education and the vocational education programs. This corresponded to Grade 13 in the Laender of the former West Germany and to Grade 12 in the Laender of the former East Germany.

Students Tested in Advanced Mathematics and Physics

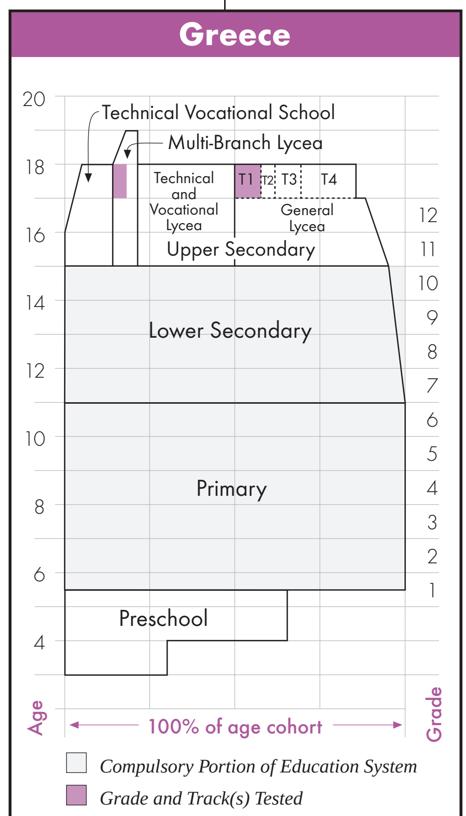
Advanced Mathematics: students in their final year, Grade 12 or 13 depending on the Laender, in advanced mathematics courses (3 to 5 periods per week).

Physics: students in their final year, Grade 12 or 13, in physics courses (3 to 5 periods per week).

Greece

Structure of Upper Secondary System

The upper secondary system in Greece is a three-year program, Grades 10 to 12, taken in the general (academic) *Lyceum*, in the multibranch, semi-comprehensive *Lyceum* or in the technical-vocational *Lyceum*. Some students attend vocational and technical schools that provide two years of education, ending at Grade 11. In the general *Lyceum*, students in Grades 10 and 11 take the same courses. Students in the final grade may follow one out of four option streams in order to prepare them for tertiary education entry examinations. The four possible streams are science and engineering (T1), medical (T2), humanities (T3), and social science (T4). They may follow an alternative cycle if they do not choose to continue their education at the tertiary level. In the technical-vocational and multibranch schools, a wide range of option cycles of vocational and/or general education is provided.



Students Tested in Mathematics and Science Literacy

Greece participated only in the advanced testing and therefore tested a limited portion of their final-year students in the *Lyceum*. It tested students in Grade 12 of the general (academic) *Lyceum* as well as students in Grade 12 of the multibranch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring mathematics and/or science.

Students Tested in Advanced Mathematics and Physics

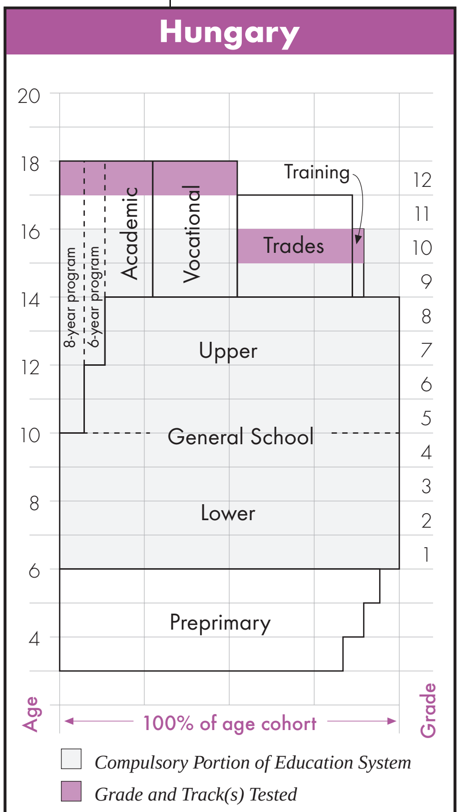
Advanced Mathematics: students in their final year, Grade 12, of the general (academic) *Lyceum* and of the multibranch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring mathematics.

Physics: students in their final year, Grade 12, of the general (academic) *Lyceum* and of the multibranch *Lyceum* taking advanced courses in mathematics and/or science in preparation for university disciplines requiring physics.

Hungary

Structure of Upper Secondary System

The upper secondary system in Hungary consists of five types of schools: a four-year academic secondary school (Grades 9 to 12), a four-year vocational secondary school (Grades 9 to 12), a three-year trade school (Grades 9 to 11), and a six-year or an eight-year academic program (Grades 7 to 12 or 5 to 12). Academic secondary schools offer general education and, for many students, lead to university. Vocational secondary schools prepare students for the work force (often technical vocations) or, alternatively, graduates may enter universities that match their vocational orientation. Trade schools and training schools emphasize practical knowledge and skills to train skilled workers. Students in the trade schools leave school after Grade 10 and spend their final year in out-of-school practice.



Students Tested in Mathematics and Science Literacy

Hungary tested students in their final year of academic secondary and vocational schools (Grade 12) and students in the final in-school year of trade school (Grade 10).

Students Tested in Advanced Mathematics and Physics

Students were not tested in advanced mathematics or physics in Hungary.

Iceland

Structure of Upper Secondary System

After completing primary and lower secondary education in Iceland, students are entitled to commence study at the upper secondary level regardless of their performance in final exams at the lower secondary level. If a student's academic standing is lower than a prescribed minimum, he/she must begin by attending special preparatory courses in basic subjects and improve his/her standing before commencing regular studies at the upper secondary level.

There are four main types of upper secondary schools in Iceland:

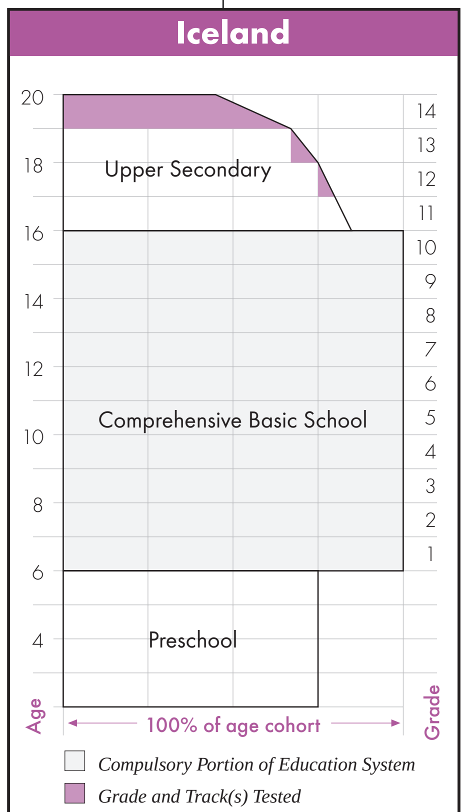
1. Grammar schools offer a four-year academic program of study leading to matriculation (*stúdentspróf*), i.e., higher education entrance examination. Students who complete the course satisfactorily are entitled to apply for admission to university.

2. Industrial-vocational schools primarily offer vocational courses that prepare students for skilled trades. They also offer studies leading to a technical matriculation examination.

ICELAND (CONT.)

3. Comprehensive schools provide academic courses comparable to those of the grammar schools and vocational training comparable to that offered by industrial-vocational schools, as well as other specialized vocational training courses.
4. Specialized vocational schools offer training for specific vocations (Seamen's and navigational colleges, The Fish Processing School, marine engineering colleges, The Technical College of Iceland, fine arts colleges, agricultural colleges, The Icelandic College for Pre-school Teachers, The Icelandic College of Social Pedagogy).

At the upper secondary level, general academic education is primarily organized as a four-year course leading to matriculation, but two-year courses are also offered. The main areas of study of these two-year courses are in education, physical education, and commerce. They are organized as part of the course leading to matriculation (70 units of the 140 required) and students in these shorter courses can therefore continue on to matriculation. Such courses are usually intended as preparatory studies for other courses within the school or at specialized vocational schools.



Traditional grammar schools and upper secondary comprehensive schools are virtually the only schools offering education leading to matriculation. There are basically six courses of academic study leading to matriculation. These are studies in languages, sociology, economics, physical education, natural sciences, and physics. Additional fine arts studies, in music, for example, may lead to matriculation, as does a technical program offered as a follow-up to vocational training.

Vocational training takes place in comprehensive schools, industrial-vocational schools, and specialized vocational schools. Subjects included in vocational programs of study can be grouped as general academic subjects, theoretical vocational subjects, and practical vocational subects. The length of the courses offered varies from one to ten semesters. Many forms of vocational training award students certification for certain types of employment. This applies especially to study in certified trades, but also to some other studies, such as the training of nurses aides and qualified skippers.

Students Tested in Mathematics and Science Literacy

Iceland tested students who were to graduate that year from an upper secondary school, that is, students in Grades 12, 13, and 14.

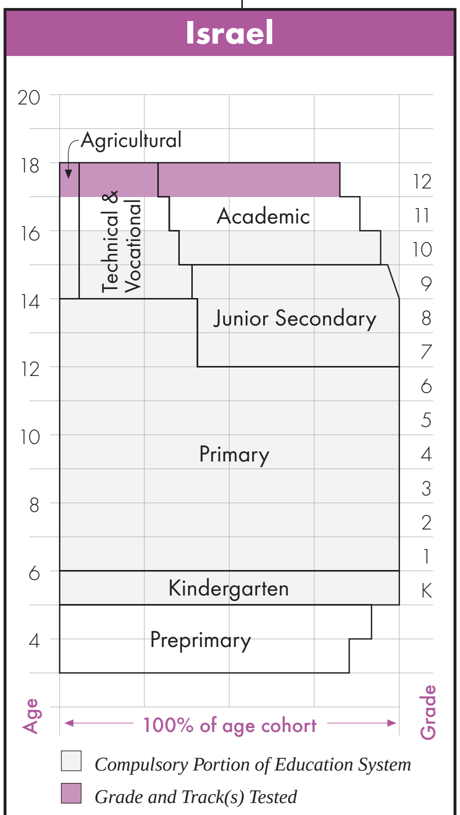
Students Tested in Advanced Mathematics and Physics

Students were not tested in advanced mathematics or physics.

Israel

Structure of Upper Secondary System

Secondary schools provide three different tracks: academic, technical and vocational, and agricultural. There are four school types: comprehensive (which cater to all three tracks); technical/vocational (vocational track); general schools (academic track); and agricultural schools (agricultural track). Programs are from 2 to 4 years and end in Grade 12. Technical education offers a range of courses, including design, computer studies, industrial automation studies, electronics, and telecommunications. Graduates of the technical track are encouraged to serve in technical units of the Israeli defense forces to continue their studies in institutes of higher education.



Students Tested in Mathematics and Science Literacy

Israel tested students in the Hebrew education system only. Students in their final year of secondary school, Grade 12, were tested, in all three tracks.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in advanced mathematics courses in Comprehensive and General schools.

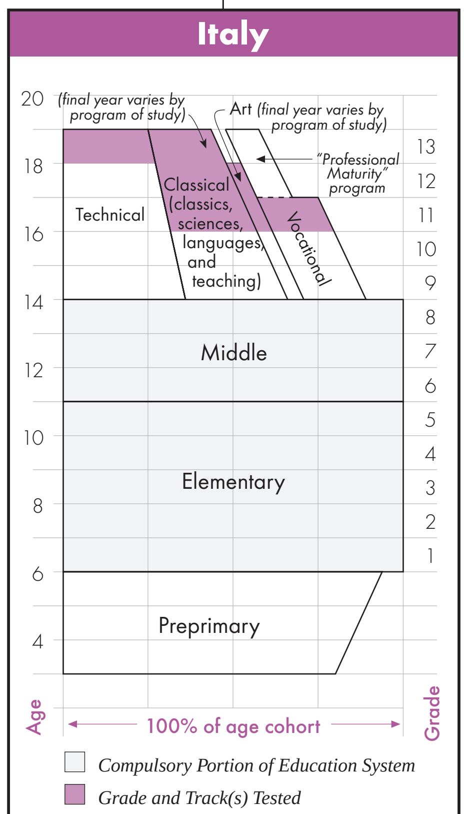
Physics: students in physics courses in Comprehensive and General schools.

ITALY

Structure of Upper Secondary System

After finishing compulsory education and passing the junior secondary school leaving examination, students in Italy may attend senior secondary school for an additional three, four, or five years. Students must pay a fee to the state and to the school they attend. There are four school types: classical schools, art schools, technical schools, and vocational schools. Classical schools include the *Liceo Classico*, which prepares humanities students for university; the *Liceo Scientifico*, which prepares mathematics and science students for university; the *Instituto Magistrale* for primary teacher education; the *Scuola Magistrale* for preprimary teacher education; and the *Liceo Linguistico* which prepares language students for university. Art schools, including the *Liceo Artistico* and the *Instituti d'Arte*, train students in the visual arts and lead to university or fine arts academies.

Technical schools, *Instituti Technici*, provide a five-year program to prepare students for professional, technical, or administrative occupations in the agricultural, industrial, or commercial sector. These schools give students access to university. Vocational schools provide a three-year program to train students to become qualified first-level technicians. Students may study an additional two years at *Instituti Professionali* and obtain a "professional maturity" designation, giving access to university.



Students Tested in Mathematics and Science Literacy

Italy tested students in all types of schools in their final year of secondary school. The final grade of school depended on the focus of study within school type. Classical studies: *Liceo Classico* (Grade 13); *Liceo Scientifico* (Grade 13); *Instituto Magistrale* (Grade 12); and *Scuola Magistrale* (Grade 11). Artistic studies: *Liceo Artistico* (Grade 12); *Instituto d'art* (Grade 12); and *Scuola d'art* (Grade 11). Vocational studies: *Instituto Professionale* (Grade 11). Technical studies: *Instituti Technici* (Grade 13). Italy did not test students in private schools.

Students Tested in Advanced Mathematics and Physics

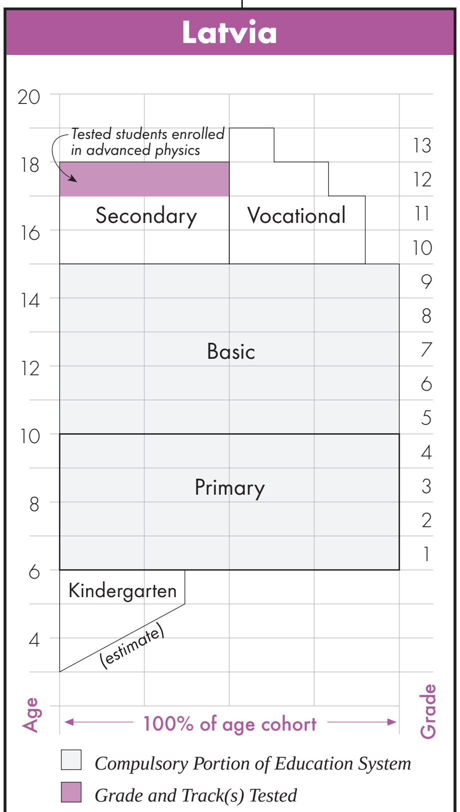
Advanced Mathematics: students in their final year of *Liceo Scientifico* (classical schools), Grade 11, 12, or 13, depending on the student's program of study, and *Instituti Technici* (technical schools), Grade 13.

Physics: students in their final year of *Liceo Scientifico* (classical schools), Grade 11, 12, or 13, depending on the student's program of study, and *Instituti Technici* (technical schools), Grade 13.

Latvia

Structure of Upper Secondary System

After basic education, Latvian students may attend secondary school (Grades 10 to 12), where they enter a three-year academic program to prepare for further studies in higher education or enter a vocational school for two to four years. In the academic secondary program, compulsory subjects include Latvian language and literature, mathematics, a foreign language, world history, Latvian history, and physical education. Optional subjects include the study of a second foreign language, economics, geography, computer science, physics, chemistry, biology, music, nature and society, and others. Vocational schools prepare students for independent technical work in various fields and include technical schools, medical schools, agricultural schools, teacher-training schools, and art schools. Vocational schools include instruction in theory and practice in the vocation of choice and some general education instruction.



Students Tested in Mathematics and Science Literacy

Latvia did not test students in mathematics and science literacy.

Students Tested in Advanced Mathematics and Physics

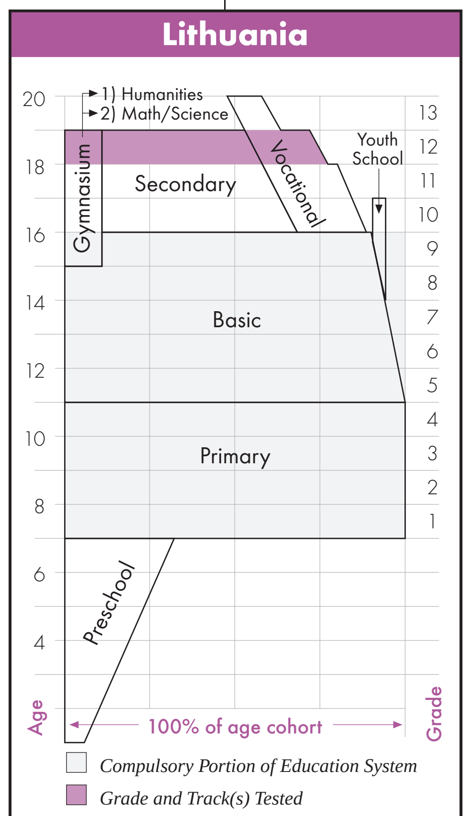
Advanced Mathematics: Latvia did not test students in advanced mathematics.

Physics: students in Grade 12, enrolled in advanced physics courses, in Latvian-speaking academic secondary schools.

Lithuania

Structure of Upper Secondary System

Upper secondary education in Lithuania includes four-year gymnasia, three-year secondary schools, and two-, three-, or four-year programs in vocational schools. The gymnasium is a four-year educational institution which offers general education at a more advanced level than that in the secondary schools. Traditionally, gymnasia are split into two programs: (1) humanities and (2) mathematics and science. Vocational schools provide general secondary education and training in a profession. There are also "youth schools" for students in basic or secondary school who are, for social reasons, unable to attend general schools. The youth schools provide a one- or two-year program after which students may reenter either the general or vocational schools.



Students Tested in Mathematics and Science Literacy

Lithuania tested students in Grade 12 in vocational, gymnasia, and secondary schools where Lithuanian is the language of instruction. Schools not under the authority of the Ministry of Education or the Ministry of Science were excluded.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year, Grade 12, of the mathematics and science gymnasia and students in secondary schools offering enhanced curriculum in mathematics.

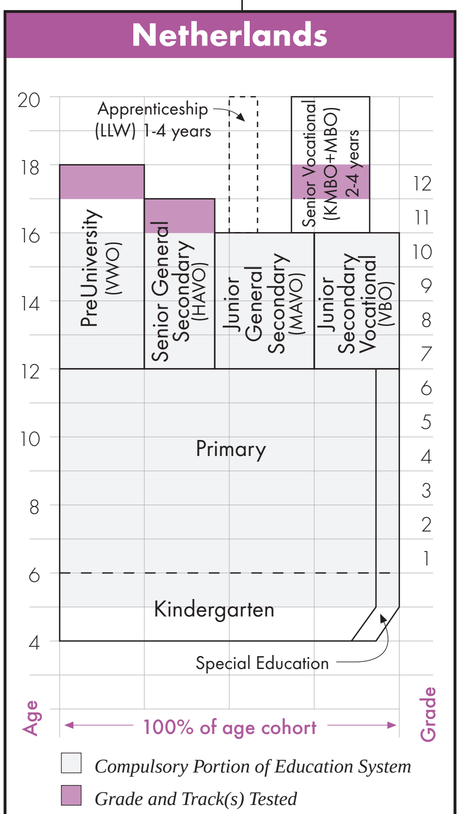
Physics: Lithuania did not test students in physics.

Netherlands

Structure of Upper Secondary System

Secondary education in the Netherlands is four to six years in duration. Students may follow one of four main tracks: pre-university education (VWO); senior general secondary education (HAVO); junior general secondary education (MAVO); or junior secondary vocational education (VBO).

VWO is a six-year program that leads to university or colleges of higher professional education. HAVO is a five-year program designed to prepare students for higher professional education. MAVO is a four-year program after which students may go on to the fourth year of HAVO, take a short or long senior secondary vocational education course (KMBO or MBO), join an apprenticeship course (LLW), or enter the labor market. VBO is a four-year course of prevocational education specializing in technical, home economics, commercial, trade, and agricultural studies. This can lead to a KMBO or MBO course, an apprenticeship course (LLW), or the labor market. As of 1993, a common core curriculum is taught in the first three grades of VBO, MAVO, HAVO, and VWO. The core curriculum includes 15 subjects, among which are mathematics, combined physics and chemistry, biology, and geography (including earth science). This was the structure of the Netherlands' education system at the time of testing (1995). As of August 1997, the MBO, KMBO, and LLW programs are designated as Senior Vocational Education, offering short and long courses on a full-time or part-time basis.



Students Tested in Mathematics and Science Literacy

The Netherlands tested students in the final year, Grade 12, of the six-year VWO (pre-university) program, students in the final year, Grade 11, of the five-year HAVO (senior general secondary) program, and students in the second year, Grade 12, of a two- to four-year MBO or KMBO (senior secondary vocational) program. These latter students would have completed a four-year MAVO program or a four-year VBO program after primary school before beginning the KMBO or MBO program. Students in the LLW (apprenticeship) programs were excluded.

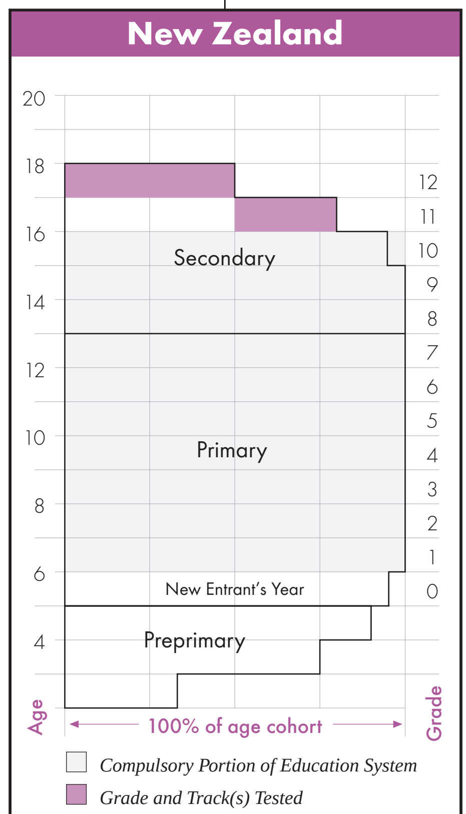
Students Tested in Advanced Mathematics and Physics

The Netherlands did not test students in advanced mathematics or physics.

New Zealand

Structure of Upper Secondary System

Education is compulsory from the ages of 6 to 16, but most children start primary school on their fifth birthday. Students in New Zealand generally have between 12-and-a-half and 13-and-a-half years of schooling, depending on the month of the year in which they were born. Secondary education in New Zealand is offered in comprehensive schools from Grades 8 to 12 (Years 9 to 13). At the lower secondary level, students are required to take a number of compulsory subjects in combination with some optional subjects. The diversity of subjects from which students may choose increases in Grades 11 and 12 (Years 12 and 13).[2] Senior students may also be studying subjects at both senior class levels. For example, a student in Grade 12 may take all Grade 12 subjects, or a combination of Grade 11 and Grade 12 subjects.



There are three national awards which students may choose to study for at secondary school, although not all students choose to participate in national examinations.[3] The first, School Certificate, is the national award undertaken by students at the end of their third year of secondary schooling (Grade 10). The second award, Sixth Form Certificate, is undertaken by most students in their fourth year of secondary schooling (Grade 11). Both certificates can be awarded in single subjects, and a candidate may enter in up to six subjects in one year for each award. The third award, University Bursaries/ Entrance Scholarship, is undertaken by the majority of students at the end of Grade 12 (Year 13). Students may elect to sit for examinations in up to five subjects. In addition, students who have completed a five-year course of study are awarded a Higher School Certificate. A student's performance in, for example, School Certificate mathematics and/or science, often determines his/her participation in these national examinations. While participation in national examinations provides an indication of subject choice, it does not, however, include the range of non-assessed courses or school-developed courses undertaken by many students in the senior school.

Students Tested in Mathematics and Science Literacy

New Zealand tested students in Grade 12 and students in Grade 11 who were not returning to school for Grade 12.

Students Tested in Advanced Mathematics and Physics

Students were not tested in advanced mathematics or physics.

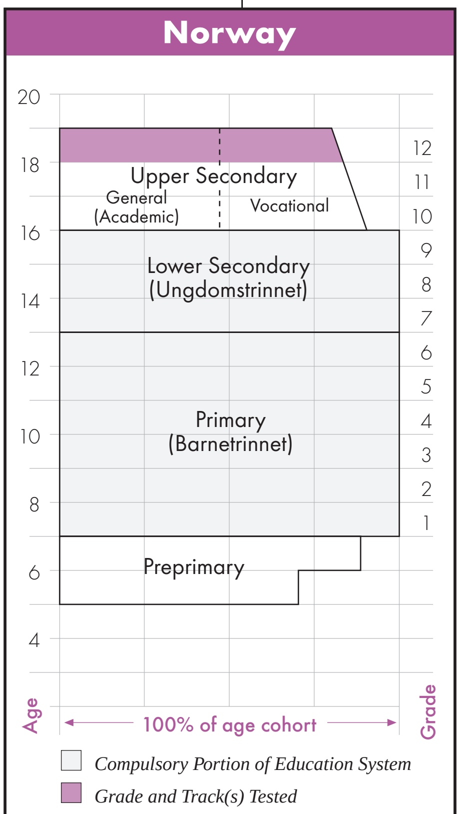
[2] Nomenclature prior to 1996: Primary school education - New Entrants to Form 2; Secondary school education - Form 3 to Form 7. The new nomenclature for class levels was introduced at the beginning of 1996, and is based on years of attendance at a school rather than on curriculum level.

[3] The three national awards are administered by the New Zealand Qualifications Authority (NZQA).

Norway

Structure of Upper Secondary System

Upper secondary education normally covers the 16-19 year age group or the period from the tenth to the twelfth year of education and training, including general and vocational education as well as apprenticeship training.



Under the system for students tested for TIMSS in 1995, general and vocational studies existed side by side in the same school. There were ten areas of study, namely: General (Academic) Studies; Commercial and Clerical Subjects; Physical Education; Craft and Aesthetic Subjects; Home Economics; Technical and Industrial Subjects; Fishing Trade Subjects; Agricultural and Rural Subjects; Maritime Subjects; and Social Studies and Health. The first three areas of study, as well as the music branch within the area of study of Aesthetic Subjects, met the requirements for admission to universities and other higher educational institutions.

This structure was rather complicated, with a varied set of offerings ranging from general schooling to vocational areas of study with special one-, two-, and three-year programs for more than 200 vocational areas.

Beginning in 1994, a simple, comprehensive system for upper secondary school was introduced. All young people between the ages of 16 and 19 have a legal right to three years of upper secondary education, qualifying them for an occupation and/or higher education.

The following three-year programs of study are offered: General and Business Studies; Music, Drama, and Dance Studies; Sports and Physical Education (all three studies qualifying for higher education); Health and Social Studies; Arts, Crafts, and Design Studies; Agriculture, Fishing, and Forestry Studies; Hotel, Cooking, Waiting, and Food Processing Trades; Building and Construction Trades; Service and Technical Building Trades; Electrical Trades; Engineering and Mechanical Trades; Chemical and Processing Trades; Carpentry. (The last ten programs normally qualify students for an occupation.) It has now become much easier for those with a vocational occupation to meet the requirements for entry to higher education. The number of courses in the second and third years are significantly reduced in the new reform.

Students Tested in Mathematics and Science Literacy

Norway tested students in Grade 12 within all areas of study.

Norway (cont.)

Students Tested in Advanced Mathematics and Physics

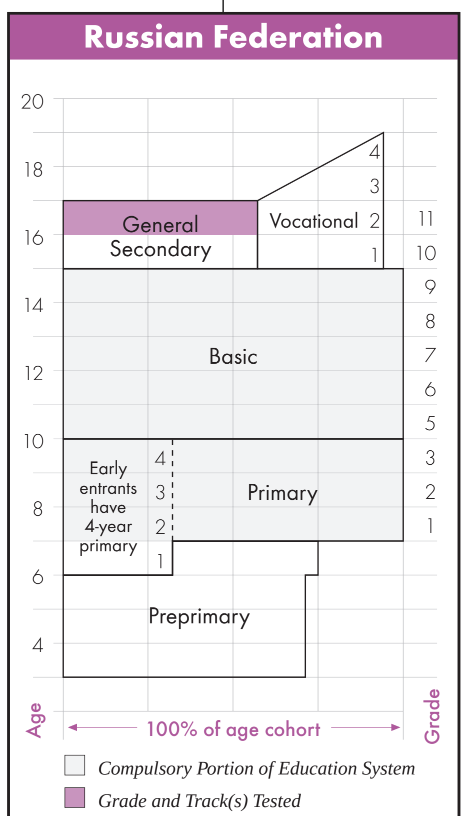
Advanced Mathematics: Norway did not test students in advanced mathematics.

Physics: students in their final year, Grade 12, of the three-year physics course in the General (Academic) Studies area. The three-year course in physics includes a foundation course in general science and two physics courses, normally taken in the second and third year.

Russian Federation

Structure of Upper Secondary System

The upper secondary education system in the Russian Federation is a two- to four-year program following compulsory education. Students in upper secondary school join either the general secondary program (usually 2 years) or vocational program (two to four years). General secondary includes general schools, schools specializing in specific disciplines, gymnasia, lycea, boarding schools, and schools for children with special needs. There are two possibilities for vocational education: initial vocational education provided in so-called professional-technical schools and secondary vocational education provided in the secondary specialized educational establishments (SSZY, technicums, colleges, etc.). All students in upper secondary education have mathematics and science as compulsory subjects. Graduates from both general secondary and vocational secondary programs may continue their education in universities or other higher educational institutions after passing the entrance examinations.



Students Tested in Mathematics and Science Literacy

The Russian Federation tested students in the final year, Grade 11, of general secondary schools. Students in the vocational program were excluded.

Students Tested in Advanced Mathematics and Physics

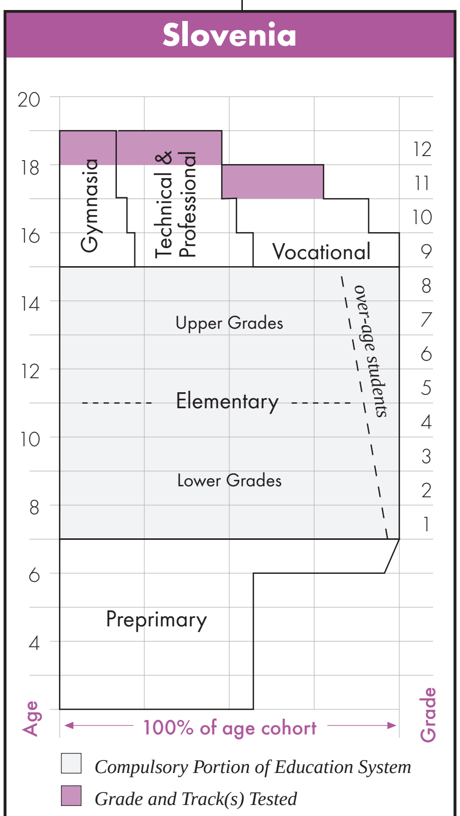
Advanced Mathematics: students in their final year, Grade 11, in general secondary schools in advanced mathematics courses or advanced mathematics and physics courses.

Physics: students in their final year, Grade 11, in general secondary schools in advanced physics courses or advanced mathematics and physics courses.

Slovenia

Structure of Upper Secondary System

There are three types of secondary schools in Slovenia: the four-year gymnasium, the four-year technical and professional school, and the two- or three-year vocational school. Students may write an entrance examination to enter tertiary education after completing any four-year upper secondary school. Gymnasia are in principle comprehensive, but some offer a science-heavy curriculum while others emphasize humanities and languages. All students must study mathematics, physics, chemistry, biology, two foreign languages, and a social sciences program of psychology, sociology, and philosophy. As of 1995, students sit for a five-subject externally assessed baccalaureate examination to enter university. The examination includes Slovenian, mathematics, a foreign language, and two subjects chosen by the student. The technical and professional baccalaureate features the same required subjects as the gymnasia, but students choose from economics, electronics, engineering, or similar subjects for the final two sessions. Vocational schools offer programs from two to four years in duration, and usually involve practical work experience as well as classroom time. All vocational schools end with a final examination that may differ from school to school.



Students Tested in Mathematics and Science Literacy

Students in Grade 12 in gymnasia and in technical secondary schools, as well as students in Grade 11 in vocational schools were tested. Students finishing vocational school in Grades 9 and 10 were not tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in their final year of gymnasia and technical and professional schools, Grade 12, were tested (all take advanced mathematics).

Physics: students in their final year of gymnasia, Grade 12, taking the physics matura exam, were tested.

Note: Slovenia has a substantial proportion of students in each grade that are older than the corresponding age shown on the diagram.

South Africa

Structure of Upper Secondary System

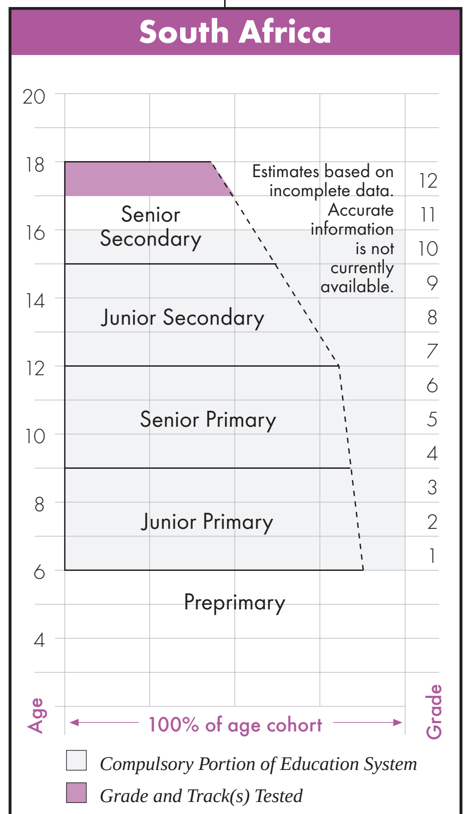
Senior secondary school in South Africa covers Grades 10 to 12. The majority of South African secondary schools are comprehensive. During the first year of senior secondary school (Grade 10), students select six subjects, including the required English and Afrikaans, defining the focus of their studies. Mathematics and science are optional subjects. There are a limited number of schools that provide commercial or technical subjects and a few that provide specialization in the arts. Because of the previous absence of compulsory schooling in South Africa, there is a wide range of entry ages in South African schools, a problem compounded by large numbers of students repeating classes and high drop-out rates.

Students Tested in Mathematics and Science Literacy

Students in Grade 12 were tested in South Africa.

Students Tested in Advanced Mathematics and Physics

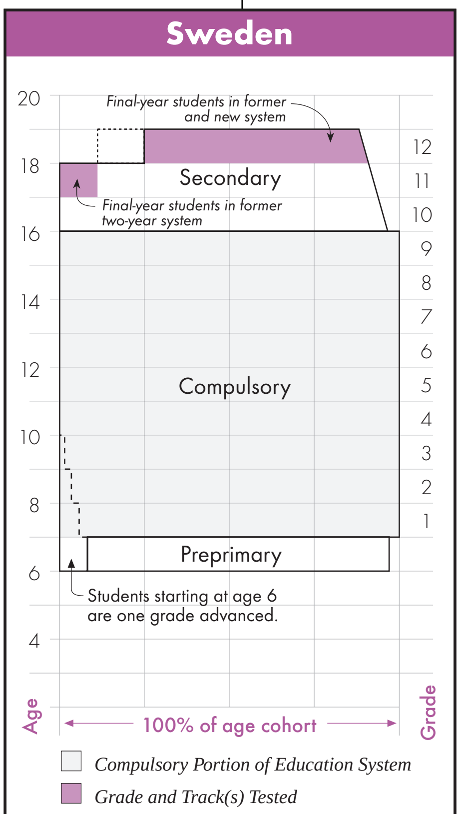
South Africa did not test students in advanced mathematics or physics.



SWEDEN

Structure of Upper Secondary System

Since 1970, upper secondary school was divided into 47 different lines (*linjer*) and some 400 specialized courses (*specialkurser*). The duration of the lines was two or three years (*2-åriga linjer* and *3-åriga linjer*, respectively). Thirty-six of the lines were practical/vocational, and 30 of these were of two years duration. Out of the 11 lines for students preparing for university, 5 were of two years duration. The lines were further divided into branches or variants. A new system of upper secondary education was implemented in the early 1990s and was fully up and running by 1996. The new upper secondary system in Sweden is organized into 16 national study programs of three years duration. Students may also follow a specially designed program or an individual program. All 16 national tracks enable students to attend university, although two tracks, Natural Science and Social Science, are specially-geared towards preparing students for university. All programs include eight core subjects: Swedish, English, civics, religious education, mathematics, general science, physical and health education, and arts activities. At the time of TIMSS testing, some schools were still on the former system where students were in upper secondary for two years, while other schools had switched to the new system of a three-year course.



Students Tested in Mathematics and Science Literacy

In schools where the new three-year upper secondary system was implemented, students in Grade 12 were tested. In schools with the former two- or three-year system, students in the final year, Grade 11 or 12, respectively, were tested.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in the final year, Grade 12, of the Natural Science or Technology lines.

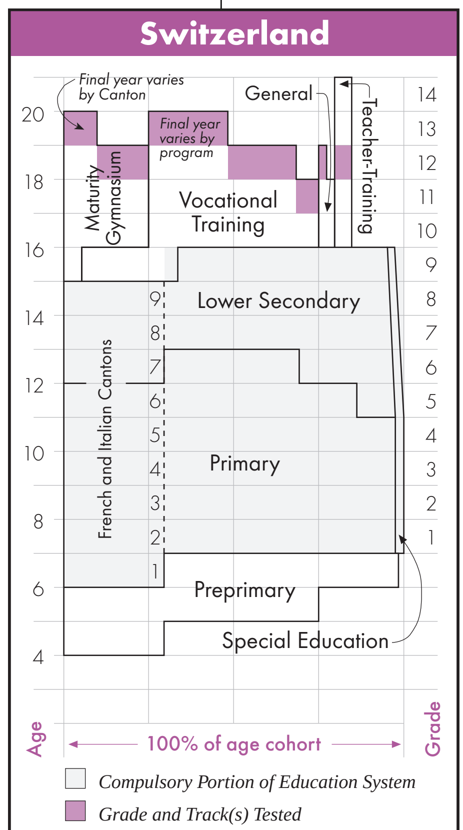
Physics: students in the final year, Grade 12, of the Natural Science or Technology lines.

Note: The diagram represents the Swedish school system during the 1994-95 school year when the system was undergoing changes.

Switzerland

Structure of Upper Secondary System

Upper secondary education in Switzerland is divided into four major types that last between 2 to 5 years, depending on the type and canton. The four types are: *Maturitätsschule* (gymnasium); general education; vocational training; and teacher training. Each major track is differentiated into a number of tracks with narrower definitions. The *Maturitätsschule* is designed to prepare students for university entrance. Typically, students enter at age 15/16, for a total of four years. The school leaving certificate gives them access to higher education. There are five types of *Maturitätsschule*: Type A (emphasis on Greek and Latin); Type B (Latin and modern languages); Type C (mathematics and science); Type D (modern languages); and Type E (economics). *Maturitätsschulen* are governed by federal regulation. The final grade in this type of school could be Grade 12, 12.5, or 13, depending on the canton.



General education schools provide general education to prepare students for certain non-university professions (such as paramedical and social fields). These programs are two or three years in duration and comprise about 3 percent of the in-school population. The upper secondary teacher training program is a five-year program that begins after compulsory education and can lead to university studies.

Vocational training is mostly in the form of apprenticeship, consisting of two basic elements: practical training on the job in an enterprise (3.5 to 4 days per week), and theoretical and general instruction in a vocational school (1 to 1.5 days per week). Vocational training is regulated by federal law and provides recognized apprenticeships of two to four years duration in approximately 280 vocations in the industrial, handicraft, and service sectors. Some students do go on to specialized tertiary institutes in the corresponding vocational field. The final year of vocational training varies by occupation.

Students Tested in Mathematics and Science Literacy

Students in their final year of gymnasium, general education, teacher training, and vocational training were tested. This corresponded to Grade 11 or 12 in gymnasium (final year depends on canton); Grade 12 in the general track; Grade 12 in the teacher-training track; and Grade 11, 12, or 13 in vocational track (final year varies by occupation).

Students Tested in Advanced Mathematics and Physics

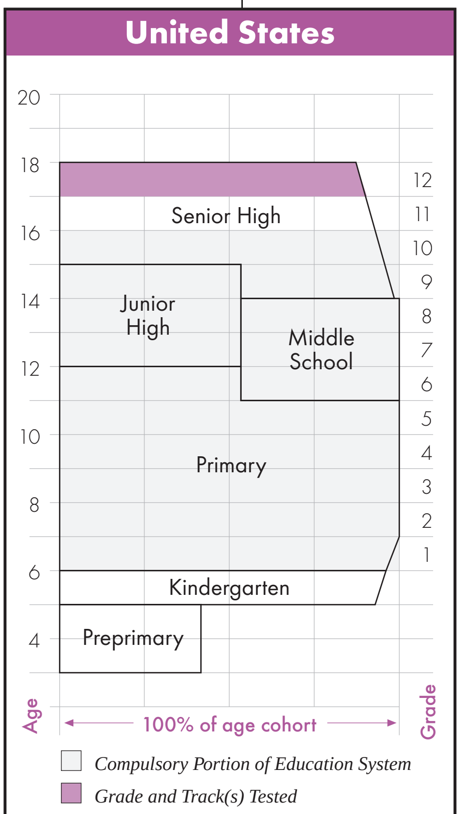
Advanced Mathematics: students in their final year, Grade 12 or 13, of *Maturitätsschule* (gymnasium), in schools and programs (A-E) with federal recognition.

Physics: students in their final year, Grade 12 or 13, of *Maturitätsschule* (gymnasium), in schools and programs (A-E) with federal recognition.

United States

Structure of Upper Secondary System

Secondary education in the United States is comprehensive and lasts from Grade 9 to 12 or 10 to 12. Students attend high schools that offer a wide variety of courses. Each student chooses or is guided in the selection of an individually unique set of courses based on their personal interests, future aspirations, or ability. Students who choose a higher proportion of courses which prepare them for university study are generally said to be in a college preparatory or "academic" school program. Those who choose a higher proportion of vocational courses are in a vocational/technical or "vocational" school program. Those whose choice of courses combines general academic and vocational coursework are in general academic or "general" school programs.



Students Tested in Mathematics and Science Literacy

Students in Grade 12 were tested in the United States.

Students Tested in Advanced Mathematics and Physics

Advanced Mathematics: students in Grade 12 who had taken Advanced Placement Calculus, Calculus, or Pre-Calculus.

Physics: students in Grade 12 who had taken Advanced Placement Physics or Physics.

Appendix B

Overview of TIMSS Procedures

History

TIMSS represents the continuation of a long series of studies conducted by the International Association for the Evaluation of Educational Achievement (IEA). Since its inception in 1959, the IEA has conducted more than 15 studies of cross-national achievement in curricular areas such as mathematics, science, language, civics, and reading. IEA conducted its First International Mathematics Study (FIMS) in 1964, and the Second International Mathematics Study (SIMS) in 1980-82. The First and Second International Science Studies (FISS and SISS) were conducted in 1970-71 and 1983-84, respectively. Since the subjects of mathematics and science are related in many respects, the third studies were conducted together as an integrated effort.[1] The number of participating countries, the number of grades tested, and testing in both mathematics and science resulted in TIMSS becoming the largest, most complex IEA study to date and the largest international study of educational achievement ever undertaken. Traditionally, IEA studies have systematically worked toward gaining a deeper insight into how various factors contribute to the overall outcomes of schooling. Particular emphasis has been placed on refining our understanding of students' opportunity to learn as this opportunity becomes defined and implemented by curricular and instructional practices. In an effort to extend what had been learned from previous studies and provide contextual and explanatory information, TIMSS was expanded beyond the already substantial task of measuring achievement in two subject areas to include a thorough investigation of curriculum and how it is delivered in classrooms around the world.

The Components of TIMSS

Continuing the approach of previous IEA studies, TIMSS defined three conceptual levels of curriculum. The **intended curiculum** is composed of the mathematics and science instructional and learning goals as defined at the system level. The **implemented curriculum** is the mathematics and science curriculum as interpreted by teachers and made available to students. The **attained curriculum** is the mathematics and science content that students have learned and their attitudes towards these subjects. To aid in interpretation and comparison of results, TIMSS also collected extensive information about the social and cultural contexts for learning, many of which are related to variations among education systems.

[1] Because of the time elapsed since earlier IEA studies, curriculum and testing methods have undergone many changes. TIMSS has sought to reflect the most current educational and measurement practices. The resulting changes in items and methods as well as differences in the populations tested make comparisons of TIMSS results with those of previous studies very difficult. The focus of TIMSS is not on measuring achievement trends, but rather on providing up-to-date information about the current quality of education in mathematics and science.

Nearly 50 countries participated in one or more components of the TIMSS data collection effort, including the curriculum analysis. To gather information about the intended curriculum, mathematics and science specialists in each participating country worked section by section through curriculum guides, textbooks, and other curricular material to categorize them in accordance with detailed specifications drawn from the TIMSS mathematics and science curriculum frameworks.[2] Initial results from this component of TIMSS can be found in two companion volumes: *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics* and *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science.*[3]

To measure the attained curriculum, TIMSS tested more than half a million students in mathematics and science at five grade levels involving the following three populations:

Population 1. Students enrolled in the two adjacent grades that contained the largest proportion of 9-year-old students at the time of testing (third- and fourth-grade students in most countries).

Population 2. Students enrolled in the two adjacent grades that contained the largest proportion of 13-year-old students at the time of testing (seventh- and eighth-grade students in most countries).

Population 3. Students in their final year of secondary education. As an additional option, countries could test two subgroups of these students: students having taken advanced mathematics, and students having taken physics.

Countries participating in the study were required to test the students in the two grades at Population 2, but could choose whether or not to participate at the other levels. In about half of the countries testing at Populations 1 and 2, subsets of the upper-grade students who completed the written tests also participated in a performance assessment consisting of hands-on mathematics and science activities. The students designed experiments, tested hypotheses, and recorded their findings. For example, in one task, students were asked to investigate probability by repeatedly rolling a die, applying a computational algorithm, and proposing explanations in terms of probability for patterns that emerged. Figure B.1 shows the countries that participated in the various components of TIMSS achievement testing.

From a broad array of questionnaires, TIMSS also collected data about how the curriculum is implemented in classrooms, including the instructional practices used to deliver it. The questionnaires were also used to collect information about the social and cultural contexts for learning. Questionnaires were distributed at the country

[2] Robitaille, D.F., McKnight, C., Schmidt, W., Britton, E., Raizen, S., and Nicol, C. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science*. Vancouver, B.C.: Pacific Educational Press.

[3] Schmidt, W.H., McKnight, C.C., Valverde, G. A., Houang, R.T., and Wiley, D. E. (1997). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Mathematics*. Dordrecht, the Netherlands: Kluwer Academic Publishers. Schmidt, W.H., Raizen, S.A., Britton, E.D., Bianchi, L.J., and Wolfe, R.G. (1997). *Many Visions, Many Aims: A Cross-National Investigation of Curricular Intentions in School Science*. Dordrecht, the Netherlands: Kluwer Academic Publishers.

Figure B.1

Countries Participating in Components of TIMSS Testing

Country	Population 1		Population 2		Population 3		
	Written Test	Peformance Assessment	Written Test	Performance Assessment	Mathematics & Science Literacy	Advanced Mathematics	Physics
Argentina			●				
Australia	●	●	●	●	●	●	●
Austria	●		●		●	●	●
Belgium (Fl)			●				
Belgium (Fr)			●				
Bulgaria			●				
Canada	●	●	●	●	●	●	●
Colombia			●	●			
Cyprus	●	●	●	●	●	●	●
Czech Republic	●	●	●	●	●	●	●
Denmark			●		●	●	●
England	●		●	●			
France			●		●	●	●
Germany			●		●	●	●
Greece	●		●			●	●
Hong Kong	●	●	●	●			
Hungary	●		●		●		
Iceland	●		●		●		
Indonesia	●		●				
Iran, Islamic Rep.	●	●	●	●			
Ireland	●		●				
Israel	●	●	●	●	●	●	●
Italy	●		●		●	●	●
Japan	●		●				
Korea	●		●				
Kuwait	●		●				
Latvia	●		●				●
Lithuania			●		●	●	
Mexico	●		●		●	●	●
Netherlands	●		●	●	●		
New Zealand	●	●	●	●	●		
Norway	●		●	●	●		●
Philippines			●				
Portugal	●	●	●	●			
Romania			●	●			
Russian Federation			●		●	●	●
Scotland	●		●	●			
Singapore	●		●	●			
Slovak Republic			●				
Slovenia	●	●	●	●	●	●	●
South Africa			●		●		
Spain			●	●			
Sweden			●	●	●	●	●
Switzerland			●	●	●	●	●
Thailand	●		●				
United States	●	●	●	●	●	●	●

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

level about decision-making and organizational features of the national education systems. Students answered questions pertaining to their attitudes towards mathematics and science, classroom activities, home background, and out-of-school activities. At Populations 1 and 2, the mathematics and science teachers of sampled students responded to questions about teaching emphasis on the topics in the curriculum frameworks, instructional practices, textbook use, professional training and education, and their views on mathematics and science. The heads of schools responded to questions about school staffing and resources, mathematics and science course offerings, and support for teachers. In addition, a volume was compiled that describes the education systems of the participating countries.[4]

With its enormous array of data, TIMSS has numerous possibilities for policy-related research, focused studies related to students' understandings of mathematics and science topics and processes, and integrated analyses linking the various components of TIMSS. The initial round of reports is only the beginning of a number of research efforts and publications aimed at increasing our understanding of how mathematics and science education functions across countries, what affects student performance, and how mathematics and science education can be improved.

Developing the TIMSS Tests

The TIMSS curriculum frameworks underlying the mathematics and science tests at all three populations were developed by groups of mathematics educators with input from the TIMSS National Research Coordinators (NRCs). As shown in Figures B.2 and B.3, the mathematics and science curriculum frameworks each contain three dimensions or aspects. The content aspect represents the subject matter content of school mathematics or science. The performance expectations aspect describes, in a non-hierarchical way, the many kinds of performance or behavior that might be expected of students in school mathematics or science. The perspectives aspect focuses on the development of students' attitudes, interest, and motivation in mathematics or science.[5]

Three tests were developed for the TIMSS assessment of students in the final year of secondary school: the mathematics and science literacy test; the advanced mathematics test; and the physics test. The tests were developed through an international consensus involving input from experts in mathematics, science, and measurement. The TIMSS Subject Matter Advisory Committee, including distinguished scholars from 10 countries, ensured that the mathematics and science literacy tests represented current conceptions of literacy in those areas, and that the advanced mathematics

[4] Robitaille, D.F. (Ed.). (1997). *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*. Vancouver, B.C.: Pacific Educational Press.

[5] The complete TIMSS curriculum frameworks can be found in Robitaille, D.F., et al. (1993). *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science*. Vancouver, B.C.: Pacific Educational Press.

Figure B.2

The Three Aspects and Major Categories of the Mathematics Framework

Content

- Numbers
- Measurement
- Geometry
- Proportionality
- Functions, relations, and equations
- Data representation, probability, and statistics
- Elementary analysis
- Validation and structure

Performance Expectations

- Knowing
- Using routine procedures
- Investigating and problem solving
- Mathematical reasoning
- Communicating

Perspectives

- Attitudes
- Careers
- Participation
- Increasing interest
- Habits of mind

Figure B.3

The Three Aspects and Major Categories of the Science Framework

Content

- Earth sciences
- Life sciences
- Physical sciences
- Science, technology, and mathematics
- History of science and technology
- Environmental issues
- Nature of science
- Science and other disciplines

Performance Expectations

- Understanding
- Theorizing, analyzing, and solving problems
- Using tools, routine procedures
- Investigating the natural world
- Communicating

Perspectives

- Attitudes
- Careers
- Participation
- Increasing interest
- Safety
- Habits of mind

and physics tests reflected current thinking and priorities in the fields of mathematics and physics. The items underwent an iterative development and review process, with multiple pilot tests. Every effort was made to ensure that the items exhibited no bias towards or against particular countries, including modifying specifications in accordance with data from the curriculum analysis component, obtaining ratings of the items from subject matter specialists in the participating countries, and conducting thorough statistical item analysis of data collected in the pilot testing. The final forms of the test were endorsed by the NRCs of the participating countries.[6] In addition, countries had an opportunity to match the content of the advanced mathematics and physics tests to their curricula at the final year of secondary schooling, identifying items measuring topics not covered in their intended curriculum. The information from this Test-Curriculum Matching Analysis indicates that omitting such items has little effect on the overall pattern of results (see Appendix C). This analysis was not conducted for the mathematics and science literacy test; that test was designed as a general measure of mathematics and science literacy and was not intended to represent the curriculum for students at the end of secondary school, and the students tested were not necessarily enrolled in mathematics and science courses at the time of testing.

The mathematics and science literacy test was designed to test students' general mathematical and scientific knowledge and understanding of mathematical and scientific principles. The mathematics items cover number sense, including fractions, percentages, and proportionality. Algebraic sense, measurement, and estimation are also covered, as are data representation and analysis. Reasoning and social utility were emphasized in several items. A general criterion in selecting the items was that they should involve the types of mathematics questions that could arise in real-life situations and that they be contextualized accordingly. Similarly, the science items selected for use in the TIMSS literacy test were organized according to three areas of science, earth science, life science, and physical science, as well as including a reasoning and social utility component. The emphasis was on measuring how well students can use their knowledge in addressing real-world problems having a science component. The test was designed to enable reporting for mathematics literacy and science literacy separately as well as overall.

In order to examine how well students understand advanced mathematics concepts and can apply knowledge to solve problems, the advanced mathematics test was developed for students in their final year of secondary school having taken advanced mathematics. This test enabled reporting of achievement overall and in three content areas: numbers, equations, and functions; calculus; and geometry. In addition to items representing these three areas, the test also included items related to probability and statistics and to validation and structure, but because there were few such items, achievement in these areas was not estimated.

[6] For a full discussion of the TIMSS tests development effort, see Garden, R.A. and Orpwood, G. (1996). "TIMSS Test Development," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College; D.F. Robitaille and R.A. Garden (Eds.), *TIMSS Monograph No. 2: Research Questions and Study Design*. Vancouver, B.C.: Pacific Educational Press; and Orpwood, G. and Garden, R.A. (1998). *Assessing Mathematics and Science Literacy, TIMSS Monograph No. 4*. Vancouver, B.C.: Pacific Educational Press.

The physics test was developed for students in their final year of secondary school who had taken physics, in order to examine how well they understand and can apply physics principles and concepts. It enabled reporting of physics achievement overall and in five content areas: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle physics, quantum and astrophysics, and relativity.

Table B.1 presents the number and type of items included in the literacy test for mathematics literacy and science literacy, and the number of score points in each category. Tables B.2 and B.3 present information about the items on the advanced mathematics and physics tests.

In each of the three tests, approximately one-third of the items were in the free-response format, requiring students to generate and write their own answers. Designed to take up about one-third of students' response time, some free-response questions asked for short answers while others required extended responses in which students needed to show their work. The remaining questions were in multiple-choice format. In scoring the tests, correct answers to most questions were worth one point. Consistent with the approach of allotting students longer response time for constructed-response questions than for multiple-choice questions, however, responses to some of these questions (particularly those requiring extended responses) were evaluated for partial credit, with a fully correct answer being awarded two or three points. This, added to the fact that some items had two parts, means that the total number of score points exceeds the number of test items.

The TIMSS instruments were prepared in English and translated into the other languages used for testing. In addition, it sometimes was necessary to adapt the international versions for cultural purposes, even in the countries that tested in English. This process represented an enormous effort for the national centers, with many checks along the way. The translation activity included: 1) developing guidelines for translation and cultural adaptation, 2) translation of the tests, by two or more independent translators in accordance with the guidelines, 3) consultation with subject-matter experts regarding cultural adaptations to ensure that the meaning and difficulty of items did not change, 4) verification of the quality of the translations by professional translators from an independent translation company, 5) corrections by the national centers in accordance with the suggestions made, 6) verification that corrections were implemented, and 7) a series of statistical checks after the testing to detect items that did not perform comparably across countries.[7]

[7] More details about the translation verification procedures can be found in Mullis, I.V.S., Kelly, D.L., and Haley, K. (1996). "Translation Verification Procedures," in M.O. Martin and I.V.S. Mullis (Eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection*. Chestnut Hill, MA: Boston College; and Maxwell, B. (1996); and "Translation and Cultural Adaptation of the TIMSS Instruments," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Table B.1

Distribution of Mathematics and Science Literacy Items by Reporting Category

Reporting Category	Percentage of Items	Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points[1]
Mathematics Literacy	58%	44	34	8	2	53
Science Literacy	42%	32	18	9	5	43
Total	100%	76	52	17	7	96

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

Table B.2

Distribution of Advanced Mathematics Items by Content Category

Content Category	Percentage of Items	Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points[1]
Numbers & Equations	26%	17	13	2	2	22
Calculus	23%	15	12	2	1	19
Geometry	35%	23	15	4	4	29
*Probability and Statistics	11%	7	5	2	0	8
*Validation and Structure	5%	3	2	0	1	4
Total	100%	65	47	10	8	82

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[1] In scoring the tests correct answers to most items were worth one point. However, responses to some constructed-response items were evaluated for partial credit with a fully correct answer awarded up to two or three points. In addition, some items had two parts. Thus, the number of score points exceeds the number of items in the test.

* Probability and Statistics and Validation and Structure were not scaled separately. However, the overall advanced mathematics scale includes those 10 items.

Table B.3

Distribution of Physics Items by Content Category

Content Category	Percentage of Items	Number of Items	Number of Multiple-Choice Items	Number of Short-Answer Items	Number of Extended-Response Items	Number of Score Points[1]
Mechanics	25%	16	11	4	1	19
Electricity and Magnetism	25%	16	10	3	3	21
Heat	14%	9	6	3	0	12
Wave Phenomena	15%	10	6	3	1	12
Modern Physics: Particle, Quantum and Astrophysics, and Relativity	22%	14	9	2	3	17
Total	100%	65	42	15	8	81

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[1] In scoring the tests correct answers to most items were worth one point. However, responses to some constructed-response items were evaluated for partial credit with a fully correct answer awarded up to two points. In addition, some items had two parts. Thus, the number of score points exceeds the number of items in the test. Because the percentages are rounded to the nearest whole number, the total may appear inconsistent.

TIMSS Test Design

The assessment of the final-year students was accomplished through a complex design that included four types of test booklets (nine booklets in total) that were distributed to students based on their academic preparation. The four types of test booklets below were intended to yield proficiency estimates in mathematics and science literacy, advanced mathematics, and physics:

- Two literacy booklets (booklets 1A and 1B) containing mathematics and science literacy items
- Three physics booklets (booklets 2A, 2B, and 2C) containing physics items only
- Three mathematics booklets (booklets 3A, 3B, and 3C) containing advanced mathematics items only
- One mathematics/physics booklet (booklet 4) containing items in physics, advanced mathematics, and mathematics and science literacy.

The TIMSS test design included 12 mutually exclusive clusters of items distributed among the four types of test booklets in a systematic fashion. The 12 clusters are labeled A through L. Each cluster could appear in more than one test booklet and, in a few cases, in different positions within the booklets. The items within a cluster always appear in the same order and position.[8]

To facilitate booklet rotation and ensure proper achievement estimates, students were classified as to their preparation in mathematics and physics. Each student was characterized as having taken advanced mathematics (M) or not (O), and as having taken physics (P) or not (O). This two-way classification yielded 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

The nine test booklets were rotated among students based on this classification scheme (OO, OP, MO, MP), so that each student completed one 90-minute test 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, although in this case it could have been any one of the booklets (1A, 1B, 2A, 2B, 2C, 3A, 3B, 3C, 4).

8 The design is fully documented in Adams, R. and Gonzalez, E. (1996). "Design of the TIMSS Achievement Instruments," in D.F. Robitaille and R.A. Garden (Eds.), *TIMSS Monograph No. 2: Research Questions and Study Design*. Vancouver, B.C.: Pacific Educational Press; and Adams, R. and Gonzalez, E. (1996). "TIMSS Test Design," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Population Definition and Sampling for Students in the Final Year of Secondary School

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 available sampling information and of the sampling activities themselves. For TIMSS, 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 in the use of the sampling software. In consultation with the TIMSS sampling referee (Keith Rust, Westat, Inc.), staff from Statistics Canada reviewed the national sampling plans, sampling data, sampling frames, and sample execution. This documentation was used by the International Study Center in consultation with Statistics Canada, the sampling referee, and the Technical Advisory Committee to evaluate the quality of the samples.

The intention of the assessment of final-year students was to measure what might be considered the "yield" of the elementary and secondary education systems of a country with regard to mathematics and science. The international desired population, then, was all students in the final year of secondary school. 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 to be part of the population (but grade 10 in the academic track is not). Appendix A provides information about the students tested in each country.

Coverage of TIMSS Population

In a few situations where TIMSS testing of the international desired population could not be implemented, 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 B.4 shows differences in coverage between the international and national desired populations. Most participants achieved 100% coverage (20 out of 24). The countries with less than 100% coverage are footnoted in tables in this 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, also limited its testing to Latvian-speaking schools. Because coverage fell below 65%, 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 define a population that excluded a small percentage (less than 10%) of certain kinds of schools or students that would be very difficult or resource-intensive to test (e.g., 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 B.4. The countries with particularly high exclusions are so footnoted in the achievement tables in the report.

Table B.4

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%	

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

TIMSS Coverage Index

A further difficulty in defining the desired population for the final-year assessment is that many students drop out before the final year of any track. This is addressed in the TIMSS final-year assessment by the calculation of a TIMSS Coverage Index (TCI) that quantifies the proportion of the entire school-leaving age cohort that is covered by the TIMSS final-year sample in each country. The TCI was defined as follows:

$$TCI = \frac{Total\ Enrollment\ in\ TIMSS\ Grades\ 1995}{(Total\ National\ Population\ Aged\ 15-19\ in\ 1995)/5}$$

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. Because some students repeat the final year of a track, or take the final year in more than one track at different times, they may be in the final year of a track but, in fact, are not completing their secondary education that year. On the one hand, students who are not completing their education still have the potential to gain further knowledge in additional years of schooling, and thus will not have attained their full yield at the time of the TIMSS assessment. On the other hand, and of more serious concern, the presence both of students who are repeating the final track, and of those who will repeat that track, can contribute a substantial downward bias to the estimated achievement of the population. Repeating students would be represented twice in the population, and are likely to be lower-achieving on average than those who do not repeat. The only practical way for TIMSS to deal with this problem was to exclude students who were repeating the final year. Thus, the population of final-year students is formally defined as those students taking the final year of one track of the secondary system for the first time.

The *denominator* in the expression is an estimate of the school-leaving age cohort size. Since the age at which students in upper secondary 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 in some countries. 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 B.5 presents the computation of the TCI for each country.

Table B.5

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%

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1994-95.

* See Appendix A for characteristics of the students sampled.

† 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.

The International Study Center tried to maximize standardization across countries in defining the students in the final year of secondary school. However, the precise definition of the mathematics and physics subpopulations was necessarily a consultative process. Each country identified the group of students that it wished to compare internationally, based on the general content of the tests and practical considerations in sampling and administration. In order to quantify the coverage of the advanced mathematics and physics samples and assist in interpreting the achievement results for these students, TIMSS computed a Mathematics TIMSS Coverage Index (MTCI) and a Physics TIMSS Coverage Index (PTCI). The MTCI is the overall TCI multiplied by the percentage of the final-year sample having taken advanced mathematics, and the PTCI is the overall TCI multiplied by the percentage of the final year sample having taken physics. The MTCI and the PTCI are estimates of the percentage of the entire school-leaving age cohort covered by the TIMSS sample of advanced mathematics and physics students respectively. These indices are presented in Table 3 of the Introduction and in the achievement tables for advanced mathematics and physics, respectively.

Samples Sizes and Participation Rates

Within countries, TIMSS used a two-stage sample design for the final year of secondary school assessment, where the first stage involved sampling 120 public and private schools in each country. Within each school, the basic approach required countries to use random procedures to select 40 students. The actual number of schools and students selected depended in part on the structure of the education system – tracked or untracked – and on where the student subpopulations were in the system.[9] School sample sizes for the literacy, advanced mathematics, and physics assessments are shown in Tables B.6, B.7, and B.8, respectively. Within each sampled school, eligible students were classified as OO, MO, OP, or MP (see TIMSS Test Design section for descriptions of these groups), and a sample of each group was drawn. Test booklets were assigned to students based on their classification. Student sample sizes by assessment type are shown in Table B.9.

Countries were required to achieve a participation rate of at least 85% of both schools and students, or a combined rate of 75% (the product of school and student participation with or without replacement schools). Tables B.10, B.11, and B.12 present the participation rates for the mathematics and science literacy, advanced mathematics, and physics assessments, respectively.

[9] The sample design for TIMSS is described in detail in Foy, P., Rust, K. and Schleicher, A., (1996). "TIMSS Sample Design," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume I.* Chestnut Hill, MA: Boston College.

Table B.6

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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Table B.7

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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

Table B.8

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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table B.9

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	24	13	4093	1040
Austria	3693	119	21	3553	398
Canada	11782	256	476	11050	1470
Cyprus	1224	14	1	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	131	3	2366	663
Israel	2568	0	0	2568	29
Italy	2426	105	46	2275	192
Latvia (LSS)	780	0	6	774	66
Lithuania	4196	0	1	4195	574
Netherlands	1882	158	43	1681	211
New Zealand	2687	549	32	2106	343
Norway	4056	0	141	3915	349
Russian Federation	5356	492	44	4820	182
Slovenia	3755	36	2	3717	282
South Africa	3695	906	0	2789	32
Sweden	5362	61	135	5166	589
Switzerland	5939	230	28	5681	262
United States	14812	279	617	13916	3082

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

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

Table B.9 (Continued)

Student Sample Sizes
Final Year of Secondary School*

Country	Number of Participating Students		
	Literacy	Advanced Mathematics	Physics
Australia	1844	548	564
Austria	1779	599	594
Canada	4832	2381	1967
Cyprus	473	330	307
Czech Republic	1899	833	819
Denmark	2604	1278	544
France	1590	796	835
Germany	2182	2189	616
Greece	0	346	349
Hungary	5091	0	0
Iceland	1703	0	0
Israel	1045	641	541
Italy	1578	360	107
Latvia (LSS)	0	0	708
Lithuania	2887	734	0
Netherlands	1470	0	0
New Zealand	1763	0	0
Norway	2518	0	1048
Russian Federation	2289	1364	985
Slovenia	1387	1301	512
South Africa	2757	0	0
Sweden	2816	749	760
Switzerland	2976	1072	1039
United States	5371	2349	2678

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.

Table B.10

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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Unweighted participation rates.

Table B.11

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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Unweighted participation rates.

Table B.12

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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Unweighted participation rates.

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

COMPLIANCE WITH SAMPLING GUIDELINES

Figures B.4, B.5, and B.6 show how countries have been grouped in tables reporting achievement results for literacy, advanced mathematics, and physics, respectively. Countries that complied with the TIMSS guidelines for school and student sampling, and that achieved acceptable participation rates (see above) 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% 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 B.4-B.6. 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 for Israel are included in Appendix D because Israel had difficulties meeting several sampling guidelines. Physics achievement results for Italy are presented in Appendix D because the sample size was inordinately low.

Figure B.4

Countries Grouped for Reporting of 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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.
[†] 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 B.5

Countries Grouped for Reporting of 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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.
† 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 B.6

Countries Grouped for Reporting of 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

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

† 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.

DATA COLLECTION

Each participating country was responsible for carrying out all aspects of the data collection, using standardized procedures developed for the study. Training manuals were developed for school coordinators and test administrators that explained procedures for receipt and distribution of materials as well as for the activities related to the testing sessions. The test administrator manuals covered procedures for test security, standardized scripts to regulate test directions and timing, rules for answering students' questions, and steps to ensure that identification on the test booklets and questionnaires corresponded to the information on the forms used to track students.

Each country was responsible for quality control and for describing this effort as part of the NRC's documenting procedures used in the study. In addition, the TIMSS International Study Center considered it essential to establish some method to monitor compliance with standardized procedures. Each NRC was asked to nominate a person, such as a retired school teacher, to serve as the quality control monitor for that country, and in almost all cases the International Study Center adopted the NRC's first suggestion. The International Study Center developed manuals for the quality control monitors and briefed them in two-day training sessions about TIMSS, the responsibilities of the national centers in conducting the study, and their own roles and responsibilities.

The quality control monitors interviewed the NRCs about data collection plans and procedures. They also selected a sample of approximately 10 schools to visit, where they observed testing sessions and interviewed school coordinators.[10] Quality control monitors observed test administration and interviewed school coordinators in 37 countries, and interviewed school coordinators or test administrators in 3 additional countries.[11]

The results of the interviews indicate that, in general, NRCs were well prepared for the data collection and, despite the heavy demands of the schedule and limited resources, were in a position to conduct it in an efficient and professional manner. Similarly, the TIMSS tests appeared to have been administered in compliance with international procedures, including the activities preliminary to the testing session, the activities during the testing sessions, and the school-level activities related to receiving and distributing materials from the national centers and returning them to it.

[10] The results of the interviews and observations by the quality control monitors are presented in Martin, M.O., Hoyle, C.D., and Gregory, K.D. (1996). "Monitoring the TIMSS Data Collection" and "Observing the TIMSS Test Administration," both in M.O. Martin and I.V.S. Mullis (Eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection*. Chestnut Hill, MA: Boston College.

[11] The TIMSS quality assurance program covered all three TIMSS populations, and was not confined to the final-year population.

SCORING THE FREE-RESPONSE ITEMS

Because approximately one-third of the written test time was devoted to free-response items, TIMSS needed to develop procedures for reliably evaluating student responses within and across countries. Scoring used two-digit codes with rubrics specific to each item. Development of the rubrics was led by the Norwegian TIMSS national center. The first digit designates the correctness level of the response. The second digit, combined with the first, represents a diagnostic code used to identify specific types of approaches, strategies, or common errors and misconceptions. Although not emphasized in this report, analyses of responses based on the second digit should provide insight into ways to help students better understand mathematics and science concepts and problem-solving approaches.

To meet the goal of implementing reliable scoring procedures based on the TIMSS rubrics, the TIMSS International Study Center prepared guides containing the rubrics and explanations of how to implement them, together with example student responses for the various rubrics. These guides, together with more examples of student responses for practice in applying the rubrics, were used as the basis for an ambitious series of regional training sessions. The sessions were designed to help representatives of national centers who would then be responsible for training personnel in their countries to apply the two-digit codes reliably.[12]

To gather and document empirical information about the within-country agreement among scorers, TIMSS developed a procedure whereby systematic subsamples of approximately 10% of the students' responses were coded independently by two readers. Tables B.13, B.14, and B.15 show the average and range of the within-country percentage of exact agreement between scorers on the free-response items in the literacy test, advanced mathematics test, and physics test, respectively. Unfortunately, lack of resources prevented several countries from providing this information. A very high percentage of exact agreement was observed for all three tests. For the literacy test, averages across items for the correctness score ranged from 91% to 98% and the overall average was 95% across the 13 countries. For the advanced mathematics test, averages across items for the correctness score ranged from 93% to 99% with an overall average of 96% across the 10 countries. For the physics test, averages across items for the correctness score ranged from 89% to 100% with an overall average of 95% across the 11 countries.

[12] The procedures used in the training sessions are documented in Mullis, I.V.S., Garden, R.A., and Jones, C.A. (1996). "Training for Scoring the TIMSS Free-Response Items," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Table B.13

TIMSS Within-Country Free-Response Coding Reliability Data Mathematics and Science Literacy

Final Year of Secondary School*

Country	Correctness Score Agreement			Diagnostic Code Agreement		
	Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement		Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement	
		Min	Max		Min	Max
Australia	94	81	99	83	61	99
Canada	91	75	99	81	60	99
Czech Republic	97	84	100	91	79	100
Denmark	95	83	100	88	68	99
France	98	91	100	95	87	99
Germany	92	70	100	82	59	100
Italy	96	88	100	89	73	99
Netherlands	92	73	100	82	62	100
New Zealand	97	91	100	92	80	100
Norway	96	83	100	90	69	100
Russian Federation	98	91	100	95	88	100
Sweden	93	81	100	85	57	100
United States	93	82	100	83	69	99
AVERAGE	95	83	100	87	70	100

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

Note: Percent agreement was computed separately for each item part, and each part was treated as a separate item in computing averages and ranges.

Table B.14

TIMSS Within-Country Free-Response Coding Reliability Data
Advanced Mathematics
Final Year of Secondary School*

Country	Correctness Score Agreement			Diagnostic Code Agreement		
	Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement		Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement	
		Min	Max		Min	Max
Australia	93	77	100	81	62	96
Canada	94	76	100	84	64	94
Czech Republic	95	87	100	87	74	97
Denmark	93	76	100	84	62	98
France	99	92	100	97	85	100
Germany	96	81	100	84	68	100
Italy	98	92	100	90	75	100
Russian Federation	98	89	100	96	89	100
Sweden	99	88	100	90	79	100
United States	96	89	100	87	65	95
AVERAGE	96	85	100	88	72	98

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

Note: Percent agreement was computed separately for each item part, and each part was treated as a separate item in computing averages and ranges.

Table B.15

TIMSS Within-Country Free-Response Coding Reliability Data – Physics
Final Year of Secondary School*

Country	Correctness Score Agreement			Diagnostic Code Agreement		
	Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement		Average of Exact Percent Agreement Across Items	Range of Exact Percent Agreement	
		Min	Max		Min	Max
Australia	90	56	100	77	46	97
Canada	92	79	100	78	61	92
Czech Republic	99	94	100	92	76	100
Denmark	90	58	100	78	43	95
France	100	96	100	95	72	100
Germany	89	65	100	74	50	95
Italy	99	86	100	97	67	100
Norway	97	90	100	93	82	100
Russian Federation	97	88	100	92	84	100
Sweden	96	80	100	90	63	100
United States	95	84	100	84	63	97
AVERAGE	95	80	100	86	64	98

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

Note: Percent agreement was computed separately for each part, and each part was treated as a separate item in computing averages and ranges.

To provide information about the cross-country agreement among scorers, TIMSS conducted a special study at Population 2, where 39 scorers from 21 participating countries evaluated common sets of students' responses to more than half of the free-response items. Unfortunately, resources did not allow an international reliability study to be conducted for Population 3; however, the results of the study at Population 2 demonstrated a very high percentage of exact agreement on the correctness and diagnostic scores. The TIMSS data from the reliability studies indicate that scoring procedures were extremely robust for the mathematics items, especially for the correctness score used for the analyses in this report.[13]

Test Reliability

Table B.16 displays for each country the median KR-20 reliability coefficient for the literacy item clusters, the advanced mathematics item clusters, and the physics item clusters. The international median, shown in the last row of the table, is the median of the reliability coefficients for all countries.

Data Processing

To ensure the availability of comparable, high-quality data for analysis, TIMSS took a rigorous set of quality control steps to create the international database.[14] TIMSS prepared manuals and software for countries to use in entering their data so that the information would be in a standardized international format before being forwarded to the IEA Data Processing Center in Hamburg for creation of the international database. Upon arrival at the Center, the data from each country underwent an exhaustive cleaning process. This process involved several iterative steps and procedures designed to identify, document, and correct deviations from the international instruments, file structures, and coding schemes. It also emphasized consistency of information within national data sets and appropriate linking among the many student, teacher, and school data files.

Throughout the process, the data were checked and double-checked by the IEA Data Processing Center, the International Study Center, and the national centers. The national centers were contacted regularly and given multiple opportunities to review the data for their countries. In conjunction with the Australian Council for Educational Research, the TIMSS International Study Center conducted a review of item statistics for each of the cognitive items in each of the countries to identify poorly performing items. Six countries had one or more mathematics items deleted (in most cases, just one). Usually the poor statistics (negative point-biserials for the key, large item-by-country interactions, and statistics indicating lack of fit with the model) were a result of translation, adaptation, or printing deviations.

[13] Details about the reliability studies can be found in Mullis, I.V.S. and Smith, T.A. (1996). "Quality Control Steps for Free-Response Scoring," in M.O. Martin and I.V.S. Mullis (Eds.), *Third International Mathematics and Science Study: Quality Assurance in Data Collection*. Chestnut Hill, MA: Boston College.

[14] These steps are detailed in Jungclaus, H. and Bruneforth, M. (1996). "Data Consistency Checking Across Countries," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume I*. Chestnut Hill, MA: Boston College.

Table B.16

Cronbach's Alpha Reliability Coefficients[1]
Final Year of Secondary School*

Country	Mathematics and Science Literacy	Advanced Mathematics	Physics
Australia	0.79	0.82	0.64
Austria	0.75	0.72	0.63
Canada	0.77	0.78	0.66
Cyprus	0.74	0.76	0.72
Czech Republic	0.80	0.82	0.70
Denmark	0.74	0.73	0.72
France	0.72	0.71	0.51
Germany	0.79	0.76	0.76
Greece	-	0.81	0.60
Hungary	0.76	-	-
Iceland	0.74	-	-
Israel	0.83	0.67	0.65
Italy	0.77	0.75	0.48
Latvia (LSS)	-	-	0.78
Lithuania	0.77	0.78	-
Netherlands	0.77	-	-
New Zealand	0.79	-	-
Norway	0.78	-	0.77
Russian Federation	0.77	0.85	0.80
Slovenia	0.77	0.78	0.71
South Africa	0.84	-	-
Sweden	0.77	0.68	0.73
Switzerland	0.76	0.78	0.69
United States	0.80	0.77	0.50
International Median	0.78	0.77	0.70

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

[1] The reliability coefficient for each country is the median KR-20 reliability across clusters in each subject. The international median is the median of the reliability coefficients for all countries.

* See Appendix A for characteristics of the students sampled.

A dash (-) indicates the data are not available.

IRT Scaling

TIMSS used an item response theory (IRT) scaling method (Rasch model) to summarize achievement on the three tests.[15] Scaling averages students' responses to the subsets of items they took in a way that accounts for differences in the difficulty of those items. An IRT approach was preferred for developing comparable estimates of performance for all students, since within each of the three components of the testing students answered different test items depending upon which of the test booklets they received. The IRT analysis provides a common scale on which performance can be compared across countries. In addition to providing a basis for estimating mean achievement, scale-scores permit estimates of how students within countries vary and provide information on percentiles of performance.

Because of the need for each of the three tests to achieve broad coverage within a limited amount of student testing time, each student was administered relatively few items within each of the subareas covered. In order to achieve reliable indices of student proficiency in this situation, it was necessary to make use of multiple imputation or "plausible values" methodology.[16] The proficiency scale scores or plausible values assigned to each student are actually random draws from the estimated ability distribution of students with similar item response patterns and background characteristics. The plausible values are intermediate values that are used in statistical analyses to provide good estimates of parameters of student populations. Although intended for use in place of student scores in analyses, plausible values are designed primarily to estimate population parameters, and are not optimal estimates of individual student proficiency.

The scaling model used in TIMSS was based on the multidimensional random coefficients logit model. The scaling was carried out with the *ConQuest* software[17] that was developed in part to meet the needs of TIMSS.

The item response model was fit to the data in two steps. In the first step the data from all countries were pooled and an international calibration of the items was undertaken using the pooled data. The data were weighted so that each country contributed equally to the calibration process. In a second step the model was fitted separately to the data for each country within the item parameters fixed at values estimated in the first step.

[15] See Adams, R.J., Wu, M., and Macaskill, G. (1997). "Scaling Methodology and Procedures," in M.O. Martin and D.L. Kelly (Eds.), *Third International Mathematics and Science Study Technical Report, Volume II.* Chestnut Hill, MA: Boston College.

[16] See Mislevy, R.J., Johnson, E.G., and Muraki, E. (1992). Scaling Procedures in NAEP. *Journal of Educational Statistics.* 17, 131-154.

[17] Wu, M.L., Adams, R.J., and Wilson, M. (1997). *Conquest: Generalized Item Response Modelling Software - Manual.* Melbourne: Australian Council for Educational Research.

The plausible values produced by the scaling procedure were in the form of logit scores that were on a scale that ranged generally between -3 and +3. For reporting purposes, these scores were mapped by a linear transformation onto an international scale with a mean of 500 and a standard deviation of 100. Each country was weighted to contribute the same when the international mean and standard deviation were set.

For the literacy test, mathematics literacy and science literacy achievement were summarized on two separate scales, each with a mean of 500 and a standard deviation of 100. The composite results for mathematics and science literacy represent an average of the results on the mathematics and science literacy scales. The overall results for advanced mathematics were derived by scaling all of the mathematics items together, also on a scale with a mean of 500 and standard deviation of 100. In a separate multidimensional scaling, achievement on items in numbers and equations, calculus, and geometry was summarized on three separate scales, each with a mean of 500[18] and a standard deviation of 100. Ten items from other content areas (probability and statistics, and validation and structure) were excluded from the content area scaling but were included in the scaling for the overall advanced mathematics test. For the physics test, achievement was summarized on five separate scales: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle physics, quantum and astrophysics, and relativity, each with a mean of 500 and a standard deviation of 100. The overall results for physics were derived from a separate scaling of all of the physics items together. In all, TIMSS conducted six separate scaling efforts for the final year students: mathematics literacy, science literacy, advanced mathematics overall, a multidimensional scaling of three content areas in advanced mathematics, physics overall, and a multidimensional scaling of five content areas in physics.

In order to quantify the uncertainty in the estimate of individual student proficiencies, TIMSS drew five plausible values for each student on each of the scales. The differences between the five values are an indication of the variability introduced by the imputation process. For the TIMSS international reports, each student proficiency statistic was computed five times, once with each plausible value, and the results were averaged to get the final, published value.

[18] Although each scale was intended to have a mean of 500, final revisions to the data for advanced mathematics students and physics students resulted in a mean of 501 for some scales.

Estimating Sampling Error

Because the statistics presented in this report are estimates of national performance based on samples of students, rather than the values that could be calculated if every student in every country had answered every question, it is important to have measures of the degree of uncertainty of the estimates. The jackknife procedure was used to estimate the standard error associated with each statistic presented in this report. The standard errors presented in the report quantify the uncertainty due to sampling variability, and also the uncertainty due to the imputation process. The use of confidence intervals, based on the standard errors, allows inferences to be made about the population means and proportions in a manner that reflects the uncertainty associated with the sample estimates. An estimated sample statistic plus or minus two standard errors represents a 95% confidence interval for the corresponding population result.

Appendix C

The Test-Curriculum Matching Analysis

When comparing student achievement across countries, it is important that the comparisons be as fair as possible. TIMSS has worked towards this goal in a number of ways that include providing detailed procedures for standardizing the population definitions, sampling, test translation, test administration, scoring, and database formation. Developing the TIMSS tests involved the interaction of experts in mathematics and the sciences with representatives of the participating countries and testing specialists.[1] The National Research Coordinators (NRCs) from each country formally approved the TIMSS tests, thus accepting them as being sufficiently fair to compare their students' achievement with that of students from other countries.

Although the TIMSS tests for final-year students having taken advanced mathematics and physics were developed to represent a set of agreed-upon advanced mathematics and physics topics, there are differences among the participating countries with respect to curricula in these fields.[2] Moreover, the amount of advanced mathematics and physics the tested students may have had varied across and within countries, depending on how each country defined the subpopulations of advanced mathematics and physics students. To restrict test items to not only the topics common to the curricula of all countries but also to those studied by all students in each country would severely limit test coverage and restrict the research questions about international differences that TIMSS is designed to examine. The TIMSS tests, therefore, inevitably contain some items measuring topics unfamiliar to some students in some countries.

The Test-Curriculum Matching Analysis (TCMA) was developed and conducted to investigate the appropriateness of the TIMSS advanced mathematics test and the TIMSS physics test for students in their final year of secondary school who had taken these subjects. It was also intended to show how student performance in individual countries varied when based only on the test questions that were judged to be relevant to their own curriculum.[3]

To gather data about the extent to which the TIMSS advanced mathematics and physics tests were relevant to the curriculum of the participating countries, TIMSS asked the NRC of each country to report whether or not each item was in their country's intended curriculum for students having taken these subjects. The NRC was asked to choose a person or persons very familiar with the curricula to make the determination. Since an item might be in the curriculum for some but not all students in a given country who had taken advanced mathematics or physics, it

[1] See Appendix B for more information on the test development.

[2] The TCMA was conducted for the advanced mathematics and physics assessments, but not for the mathematics and science literacy component of the TIMSS final-year assessment.

[3] Because there also may be curriculum areas covered in some countries that are not covered by the TIMSS tests, the TCMA does not provide complete information about how well the TIMSS tests cover national curricula.

was deemed appropriate if it was in the intended curriculum for more than 50% of the students. The NRCs had considerable flexibility in selecting items and may have considered items inappropriate for other reasons. Thirteen countries participated in the analysis for advanced mathematics and twelve countries in that for physics. Tables C.1 and C.2 present the TCMA results for advanced mathematics and physics, respectively.

The first row of Table C.1 indicates that by and large the countries considered the advanced mathematics items to be appropriate for their students. The number of score points represented by the selected items ranged from approximately 75% (62 out of 82) in Sweden to 100% in Austria and the United States.[4] About half of the countries selected items representing at least 85% of the score points. Table C.1 also shows that the different sets of items countries selected for this analysis generally did not affect their relative standing on the advanced mathematics test.

The first column in Table C.1 shows the overall average percentage correct for each country on the advanced mathematics test.[5] The countries are presented in the order of their overall performance, from highest to lowest. To interpret these tables, reading across a row provides the average percentage correct for the students in that country on the items selected by each country listed across the top of the table. For example, France, where the average percentage correct was 57% on its own set of items, had 60% for the items selected by Australia, 58% for those selected by the Russian Federation, 59% for those selected by Switzerland, and so forth. The column for a country shows how each of the other countries performed on the subset of items selected for its own students. Using the items selected by Switzerland as an example, 59% of the French students answered these items correctly, on average, 53% of the Australian students, 54% of the Russian students, and so forth. The shaded diagonal elements in each table show how each country performed on the subset of items that it selected based on its own curriculum. Thus, Swiss students averaged 53% correct on the items identified by Switzerland for this analysis.

The international averages of each country's selected advanced mathematics items presented across the last row of the table show that the difficulty of the items selected by the participating countries was fairly consistent and similar to the difficulty of the entire test, ranging from 44% to 49%. The performance of countries on the various item selections did vary somewhat, but generally not significantly.[6]

4 Of the 65 items in the advanced mathematics test, some were assigned more score points than others. In particular, some items had two parts, and some extended-response items were scored on a two- or three-point scale. The total number of score points available for analysis was 82. The TCMA uses the score points in order to give the same weight to items that they received in the test scoring.

5 Note that the performance levels presented in Tables C.1 and C.2 are based on the average percentage correct, which differs from the average scale scores presented in Chapters 5 and 8. The cost and delay of scaling for the TCMA analyses would have been prohibitive.

6 Small differences in performance in Tables C.1 and C.2 generally are not statistically significant. The standard errors for the estimated average percent correct statistics can found in Tables C.3 and C.4. We can say with 95% confidence that the value for the entire population will fall within the sample estimate plus or minus two standard errors.

Comparing the diagonal element for a country with its overall average percentage correct shows the difference between performance on the subset of items chosen by the country and on the test as a whole. In general, where there was an increase in a country's performance on its own subset of items, it was small. The largest differences were in Sweden and Denmark, where the average percentages correct were 47% and 49%, respectively, for all items and 52% and 54%, respectively, for their subsets of items.

Table C.2 presents the results of the TCMA for physics. The first row of the table shows that, as in advanced mathematics, by and large the countries considered the physics items to be appropriate for their physics students. The number of score points represented by the items selected by each country, however, varies more than for advanced mathematics (see Table C.1), ranging from approximately 47% (38 out of 81) in the Russian Federation to 100% in Austria and the United States.[7] Half of the countries, however, selected at least 85% of the score points.

The international averages for each country's selected physics items presented across the last row of the table show that items selected by the participating countries were fairly consistent in terms of difficulty, and similar to the difficulty of the entire test. Most ranged from 33% to 37%, although the Russian Federation's had an international average of 43%.

The items countries rejected tended to be difficult for their own students, but tended to be difficult for students in other countries as well. The analysis shows that omitting items considered to be inappropriate tends to improve the results for that country, but also those for all other countries, so that the relative standing of countries is largely unaffected. For example, in the Russian Federation, the average percentage correct was 42% for all physics items and 56% for its selected items, indicating that the latter were easier for these students than the test as a whole. The same subset of items, however, was also easier for students in other countries, as can be seen by looking down the column for the Russian Federation and at the international average.

In general, the selection of items has no major effect on the relationship among countries on either the mathematics or physics tests. Countries that had substantially higher or lower performance on the overall tests also had higher or lower relative performance on the different sets of items selected for the TCMA. For example, in advanced mathematics, France had the highest average percentage correct on the test as a whole and on all of the item selections, with Australia, the Russian Federation, and Switzerland among the four highest-performing countries in almost all cases. In physics, Slovenia, the Russian Federation, and Denmark were among the highest-performing countries on the test overall, as well as on the subset of items selected by each other country. Although there are some changes in the ordering of countries based on the items selected for the TCMA, most of these differences are within the boundaries of sampling error.

[7] Similar to the advanced mathematics test, some physics items had two parts, and the extended-response items were awarded 2 points for full credit. The total number of score points available for the 65 physics items was 81.

Table C.1

Test-Curriculum Matching Analysis Results - Advanced Mathematics

Final Year of Secondary School*

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table C.3 for Corresponding Standard Errors)

Instructions: Read ***across*** the row to compare that country's performance based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name to compare the performance of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** to compare performance for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	France	*Australia*	Russian Federation	Switzerland	Cyprus	*Denmark*	Sweden	Canada	Czech Republic	*Slovenia*	Germany	*Austria*	*United States*
	(Number of Score Points Included) *82***	*80*	*71*	*67*	*72*	*76*	*65*	*62*	*70*	*80*	*81*	*65*	*82*	*82*
France	58 (1.1)	57	60	58	59	56	61	61	56	57	57	59	58	58
Australia	52 (2.2)	51	55	51	53	50	54	55	50	52	51	53	52	52
Russian Federation	52 (1.7)	52	55	56	54	52	56	56	51	52	52	55	52	52
Switzerland	50 (0.8)	50	52	50	53	48	54	54	48	50	49	52	50	50
Cyprus	49 (1.2)	48	51	50	50	48	52	52	47	49	48	50	49	49
Denmark	49 (0.8)	49	52	49	52	47	54	54	46	49	48	52	49	49
Sweden	47 (0.9)	47	50	46	49	45	51	52	46	47	47	50	47	47
Canada	47 (0.8)	46	49	46	49	45	51	51	46	47	46	49	47	47
Czech Republic	40 (1.9)	40	42	41	41	39	43	43	39	40	40	42	40	40
Slovenia	39 (1.7)	39	41	38	40	37	42	42	38	39	39	40	39	39
Germany	38 (1.1)	38	40	38	41	36	42	42	35	38	37	40	38	38
Austria	35 (1.2)	35	37	34	37	33	39	39	33	35	34	37	35	35
United States	35 (1.0)	35	37	34	37	33	38	39	34	35	34	37	35	35
International Average	**45 (1.3)**	**45**	**48**	**45**	**47**	**44**	**49**	**49**	**44**	**45**	**45**	**47**	**45**	**45**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
** Of the 65 items in the advanced mathematics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 82 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.5).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table C.2

Test-Curriculum Matching Analysis Results - Physics

Final Year of Secondary School*

Average Percent Correct Based on Subsets of Items Specially Identified by Each Country as Addressing Its Curriculum (See Table C.4 for Corresponding Standard Errors)

Instructions: Read ***across*** the row to compare that country's performance based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name to compare the performance of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** to compare performance for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	*Slovenia*	**Russian Federation**	*Denmark*	**Germany**	*Australia*	**Cyprus**	**Switzerland**	**Canada**	**France**	**Czech Republic**	*Austria*	*United States*
	(Number of Score Points Included)												
	81*	***78***	***38***	***73***	***78***	***78***	***78***	***43***	***59***	***60***	***77***	***81***	***81***
Slovenia	42 (2.5)	42	51	43	41	42	42	45	43	41	42	42	42
Russian Federation	42 (1.9)	42	56	42	41	42	42	44	42	42	43	42	42
Denmark	40 (0.9)	39	52	42	40	40	40	43	41	39	40	40	40
Germany	39 (2.0)	38	44	39	39	39	39	40	41	38	39	39	39
Australia	37 (0.9)	37	46	38	37	38	37	40	38	37	37	37	37
Cyprus	36 (0.9)	36	43	37	36	37	36	40	37	36	36	36	36
Switzerland	32 (0.6)	31	39	32	31	32	32	36	31	30	32	32	32
Canada	31 (0.6)	31	42	32	31	31	31	34	32	30	32	31	31
France	30 (0.6)	29	39	31	30	30	30	32	29	30	30	30	30
Czech Republic	28 (1.0)	27	37	28	27	27	28	31	27	26	28	28	28
Austria	25 (0.9)	24	32	25	25	25	25	28	25	23	25	25	25
United States	23 (0.5)	22	32	23	22	23	23	26	22	21	23	23	23
International Average	**34 (1.1)**	**33**	**43**	**34**	**33**	**34**	**34**	**37**	**34**	**33**	**34**	**34**	**34**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
** Of the 65 items in the physics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 81 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.6).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table C.3

Standard Errors for the Test-Curriculum Matching Analysis Results - Advanced Mathematics
Final Year of Secondary School*

See Table C.1 for the Test-Curriculum Matching Analysis Results

Instructions: Read ***across*** the row for the standard error for the score based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name for the standard error for the score of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** for the standard error for the score for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	**France**	*Australia*	**Russian Federation**	**Switzerland**	**Cyprus**	*Denmark*	**Sweden**	**Canada**	**Czech Republic**	*Slovenia*	**Germany**	*Austria*	*United States*
	(Number of Score Points Included) *82***	*80*	*71*	*67*	*72*	*76*	*65*	*62*	*70*	*80*	*81*	*65*	*82*	*82*
France	58 (1.1)	1.1	1.1	1.1	1.1	1.1	1.1	1.1	1.2	1.1	1.1	1.1	1.1	1.1
Australia	52 (2.2)	2.2	2.4	2.4	2.3	2.3	2.4	2.4	2.4	2.3	2.3	2.4	2.2	2.2
Russian Federation	52 (1.7)	1.7	1.7	1.7	1.7	1.7	1.6	1.6	1.7	1.7	1.7	1.7	1.7	1.7
Switzerland	50 (0.8)	0.8	0.8	0.9	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.9	0.8	0.8
Cyprus	49 (1.2)	1.2	1.2	1.2	1.2	1.3	1.2	1.1	1.3	1.2	1.2	1.2	1.2	1.2
Denmark	49 (0.8)	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.8	0.7	0.7
Sweden	47 (0.9)	0.9	0.9	1.0	0.9	0.9	0.9	0.9	1.0	0.9	0.9	1.0	0.9	0.9
Canada	47 (0.8)	0.8	0.8	0.8	0.8	0.7	0.8	0.8	0.7	0.7	0.8	0.8	0.8	0.8
Czech Republic	40 (1.9)	2.0	2.0	2.0	1.9	2.0	1.9	2.0	2.0	1.9	1.9	2.0	1.9	1.9
Slovenia	39 (1.7)	1.7	1.8	1.7	1.7	1.7	1.7	1.7	1.8	1.7	1.7	1.7	1.7	1.7
Germany	38 (1.1)	1.1	1.1	1.1	1.2	1.0	1.2	1.1	1.0	1.1	1.1	1.1	1.1	1.1
Austria	35 (1.2)	1.2	1.2	1.2	1.3	1.1	1.3	1.3	1.1	1.2	1.2	1.3	1.2	1.2
United States	35 (1.0)	1.0	1.1	1.0	1.0	1.0	1.1	1.1	1.0	1.0	1.0	1.0	1.0	1.0
International Average	**45 (1.3)**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**	**1.3**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.
** Of the 65 items in the advanced mathematics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 82 total score points.
( ) Standard errors for the average percent of correct responses on all items appear in parentheses.
Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.5).
Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table C.4

Standard Errors for the Test-Curriculum Matching Analysis Results - Physics

Final Year of Secondary School*

See Table C.2 for the Test-Curriculum Matching Analysis Results

Instructions: Read ***across*** the row for the standard error for the score based on the test items included by each of the countries across the top.
Read ***down*** the column under a country name for the standard error for the score of the country down the left on the items included by the country listed on the top.
Read along the ***diagonal*** for the standard error for the score for each different country based on its own decisions about the test items to include.

Country	*Average Percent Correct on All Items*	*Slovenia*	**Russian Federation**	*Denmark*	**Germany**	*Australia*	**Cyprus**	**Switzerland**	**Canada**	**France**	**Czech Republic**	*Austria*	*United States*
	(Number of Score Points Included)												
	*81***	*78*	*38*	*73*	*78*	*78*	*78*	*43*	*59*	*60*	*77*	*81*	*81*
Slovenia	42 (2.5)	2.6	2.8	2.7	2.5	2.5	2.5	2.2	2.7	2.7	2.5	2.5	2.5
Russian Federation	42 (1.9)	1.9	2.0	1.9	1.9	1.9	1.9	1.7	1.8	1.9	1.9	1.9	1.9
Denmark	40 (0.9)	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9	0.9	0.9
Germany	39 (2.0)	2.0	1.6	2.0	2.0	2.0	2.0	1.8	2.2	2.0	2.0	2.0	2.0
Australia	37 (0.9)	0.9	1.1	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	0.9	0.9
Cyprus	36 (0.9)	0.9	0.9	0.9	0.9	0.9	1.0	1.1	1.0	1.0	1.0	0.9	0.9
Switzerland	32 (0.6)	0.6	0.7	0.6	0.6	0.6	0.6	0.7	0.6	0.6	0.6	0.6	0.6
Canada	31 (0.6)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
France	30 (0.6)	0.7	0.6	0.7	0.6	0.6	0.6	0.7	0.7	0.7	0.6	0.6	0.6
Czech Republic	28 (1.0)	1.0	1.1	1.0	1.0	1.0	1.0	1.0	1.0	1.1	1.0	1.0	1.0
Austria	25 (0.9)	0.9	1.0	0.9	0.9	0.9	0.9	1.0	1.0	0.9	0.9	0.9	0.9
United States	23 (0.5)	0.5	0.6	0.5	0.5	0.4	0.4	0.5	0.5	0.5	0.5	0.4	0.4
International Average	**34 (1.1)**	**1.1**	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.1**	**1.1**	**1.1**

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

** Of the 65 items in the physics test, some items had two parts and some extended-response items were scored on a multi-point scale, resulting in 81 total score points.

( ) Standard errors for the average percent of correct responses on all items appear in parentheses.

Countries shown in italics did not satisfy one or more guidelines for sample participation rates or student sampling procedures (see Figure B.6).

Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Appendix D

Selected Achievement Results for Israel and Italy

Table D.1

Israel - Selected Achievement Results in Mathematics and Science Literacy Unweighted Data

Distributions of Mathematics and Science Literacy Achievement for Students in the Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
484 (12.1)	17.7	281 (19.7)	402 (13.3)	488 (12.5)	569 (16.0)	677 (13.2)

Gender Differences in Mathematics and Science Literacy Achievement for Students in the Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	509 (12.9)	42 (3.4)	458 (14.3)	52 (19.3)

Distributions of Mathematics Literacy Achievement for Students in the Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
480 (12.2)	17.7	286 (14.4)	399 (13.9)	483 (14.0)	564 (15.2)	671 (9.7)

Gender Differences in Mathematics Literacy Achievement for Students in the Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	504 (13.7)	42 (3.4)	455 (13.4)	49 (19.1)

Distributions of Science Literacy Achievement for Students in the Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
487 (12.3)	17.7	263 (25.7)	402 (13.7)	492 (11.7)	580 (11.1)	697 (10.1)

Gender Differences in Science Literacy Achievement for Students in the Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	515 (12.5)	42 (3.4)	460 (15.8)	54 (20.2)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table D.2

Israel - Selected Achievement Results in Advanced Mathematics – Unweighted Data

Distributions of Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
557 (5.3)	17.7	441 (10.4)	514 (5.9)	557 (5.7)	603 (7.3)	674 (16.5)

Gender Differences in Advanced Mathematics Achievement for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
58 (3.4)	569 (6.7)	42 (3.4)	546 (4.0)	23 (7.8)

Achievement in Advanced Mathematics Content Areas for Students Having Taken Advanced Mathematics
Final Year of Secondary School*

Numbers and Equations	Calculus	Geometry
547 (4.5)	538 (4.4)	562 (5.5)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table D.3

Israel - Selected Achievement Results in Physics – Unweighted Data

Distributions of Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
506 (6.4)	17.7	368 (10.3)	454 (4.2)	507 (9.7)	562 (8.4)	639 (11.4)

Gender Differences in Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Males		Females		Difference
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement	
78 (1.6)	513 (6.7)	22 (1.6)	482 (8.7)	31 (11.0)

Achievement in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Mechanics	Electricity and Magnetism	Heat	Wave Phenomena	Modern Physics: Particle, Quantum and Astrophysics, and Relativity
548 (5.5)	557 (6.7)	478 (4.1)	444 (6.1)	476 (7.2)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Table D.4

Italy - Selected Achievement Results in Physics (Small Sample Size)

Distributions of Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

PTCI†	Mean	Average Age	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
9%	436 (10.3)	19.0	305 (21.2)	377 (11.0)	438 (21.7)	490 (12.2)	562 (14.2)

Gender Differences in Physics Achievement for Students Having Taken Physics Final Year of Secondary School*

Males		Females		Difference	PTCI†
Percent of Students	Mean Achievement	Percent of Students	Mean Achievement		
51 (3.2)	461 (14.8)	49 (3.2)	410 (11.4)	51 (18.6)	9%

Achievement in Physics Content Areas for Students Having Taken Physics Final Year of Secondary School*

Mechanics	Electricity and Magnetism	Heat	Wave Phenomena	Modern Physics: Particle, Quantum and Astrophysics, and Relativity
420 (14.4)	473 (10.5)	490 (8.4)	445 (15.5)	421 (9.3)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of the students sampled.

† The Physics TIMSS Coverage Index (PTCI) is an estimate of the percentage of the school-leaving age cohort covered by theTIMSS final-year physics student sample (see Appendix B for more information).

( ) Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

Appendix E

Percentiles and Standard Deviations of Achievement

Table E.1

Percentiles of Achievement in Mathematics and Science Literacy
Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	366 (20.6)	462 (12.5)	526 (9.4)	585 (9.7)	682 (15.7)
Austria	395 (6.6)	463 (6.1)	514 (7.6)	573 (4.7)	655 (11.5)
Canada	395 (6.3)	468 (3.4)	523 (3.8)	579 (5.0)	668 (4.8)
Cyprus	336 (5.8)	398 (4.3)	442 (3.0)	490 (4.0)	577 (8.8)
Czech Republic	344 (12.1)	411 (10.1)	463 (12.1)	531 (15.6)	649 (13.8)
Denmark	399 (8.2)	470 (4.9)	525 (4.1)	584 (4.7)	665 (3.9)
France	383 (10.2)	455 (5.1)	503 (5.9)	556 (5.6)	630 (4.3)
Germany	351 (14.5)	435 (12.0)	494 (4.9)	555 (5.0)	643 (11.4)
Hungary	351 (4.1)	416 (3.0)	469 (4.0)	531 (3.4)	628 (8.2)
Iceland	418 (8.7)	487 (3.4)	538 (3.7)	592 (4.0)	676 (6.9)
Italy	343 (10.2)	418 (6.8)	473 (6.6)	529 (4.9)	614 (19.3)
Lithuania	332 (12.1)	410 (8.5)	465 (8.5)	520 (6.7)	598 (8.7)
Netherlands	420 (7.2)	498 (8.5)	561 (7.5)	617 (6.4)	697 (8.1)
New Zealand	370 (20.2)	464 (3.9)	526 (5.7)	587 (3.9)	678 (5.4)
Norway	403 (6.3)	474 (3.4)	530 (6.0)	592 (7.5)	693 (9.7)
Russian Federation	350 (5.1)	418 (3.9)	468 (6.5)	531 (7.3)	623 (15.3)
Slovenia	378 (12.9)	457 (8.7)	516 (11.0)	568 (8.0)	653 (17.3)
South Africa	254 (5.7)	294 (3.4)	329 (3.6)	381 (16.2)	538 (27.0)
Sweden	413 (6.8)	490 (5.1)	549 (5.7)	615 (4.7)	716 (7.9)
Switzerland	389 (8.4)	472 (9.0)	529 (5.3)	590 (7.2)	678 (5.7)
United States	334 (7.9)	407 (4.2)	465 (4.1)	527 (3.3)	627 (4.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.2

Percentiles of Achievement in Mathematics Literacy
Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	357 (17.5)	459 (9.4)	523 (8.6)	585 (9.5)	684 (10.4)
Austria	393 (9.2)	461 (7.9)	515 (6.4)	573 (6.4)	653 (8.9)
Canada	375 (5.8)	457 (4.6)	516 (4.5)	579 (3.8)	674 (5.3)
Cyprus	329 (6.0)	395 (2.2)	442 (5.0)	493 (4.0)	572 (3.9)
Czech Republic	328 (12.2)	394 (10.3)	450 (15.9)	530 (16.5)	648 (13.6)
Denmark	406 (8.2)	487 (5.6)	548 (6.4)	609 (4.7)	689 (6.2)
France	392 (8.6)	468 (6.3)	523 (3.7)	578 (6.9)	655 (9.9)
Germany	347 (10.5)	432 (11.3)	494 (6.7)	554 (8.9)	652 (8.0)
Hungary	343 (3.8)	417 (3.1)	477 (3.8)	545 (3.5)	644 (6.6)
Iceland	393 (5.3)	472 (4.0)	531 (3.0)	592 (3.2)	683 (6.6)
Italy	336 (15.3)	417 (7.5)	475 (6.3)	534 (4.6)	619 (11.7)
Lithuania	329 (8.8)	412 (9.1)	470 (7.0)	529 (8.3)	606 (5.4)
Netherlands	407 (5.7)	498 (7.1)	565 (6.1)	622 (5.2)	704 (16.0)
New Zealand	358 (7.4)	453 (7.0)	523 (6.3)	589 (5.2)	685 (6.7)
Norway	384 (7.7)	461 (6.1)	523 (4.1)	592 (4.5)	691 (6.8)
Russian Federation	342 (6.4)	410 (4.8)	464 (6.0)	528 (7.8)	622 (16.6)
Slovenia	365 (13.7)	451 (8.5)	516 (7.4)	573 (6.6)	652 (5.7)
South Africa	264 (3.2)	304 (3.8)	337 (4.9)	380 (10.4)	532 (33.7)
Sweden	396 (6.4)	483 (5.1)	546 (4.8)	620 (4.1)	722 (6.8)
Switzerland	395 (7.4)	478 (7.9)	539 (7.9)	601 (5.5)	684 (5.3)
United States	325 (4.4)	395 (3.8)	454 (4.4)	521 (6.7)	621 (7.4)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.3

Percentiles of Achievement in Science Literacy
Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	361 (14.5)	462 (12.2)	525 (8.5)	591 (13.6)	689 (4.0)
Austria	388 (5.6)	460 (8.3)	513 (7.3)	575 (9.6)	672 (23.5)
Canada	396 (7.1)	475 (5.8)	529 (3.6)	588 (3.8)	673 (5.2)
Cyprus	319 (8.7)	392 (11.6)	443 (5.6)	499 (7.5)	599 (10.8)
Czech Republic	349 (9.5)	424 (9.2)	477 (11.6)	540 (12.1)	655 (12.8)
Denmark	369 (6.1)	448 (4.9)	505 (5.6)	568 (7.0)	657 (5.4)
France	358 (7.9)	434 (5.4)	485 (8.4)	542 (7.9)	618 (5.6)
Germany	350 (12.2)	437 (7.4)	494 (6.7)	556 (6.3)	649 (11.1)
Hungary	342 (2.9)	410 (3.5)	463 (2.2)	524 (3.7)	624 (6.1)
Iceland	429 (5.0)	497 (1.9)	545 (3.3)	598 (2.1)	680 (3.8)
Italy	339 (11.4)	417 (6.5)	470 (4.6)	528 (6.0)	624 (17.2)
Lithuania	324 (13.5)	403 (7.5)	460 (7.4)	517 (4.6)	601 (9.1)
Netherlands	421 (9.0)	498 (6.1)	556 (6.4)	616 (10.5)	702 (19.8)
New Zealand	369 (16.8)	467 (8.9)	530 (7.0)	592 (4.4)	683 (5.2)
Norway	404 (6.9)	480 (5.2)	539 (2.7)	600 (7.4)	706 (11.6)
Russian Federation	338 (6.1)	418 (6.9)	476 (9.3)	541 (9.2)	638 (13.7)
Slovenia	384 (10.1)	459 (8.7)	514 (8.7)	571 (10.3)	662 (22.5)
South Africa	228 (4.8)	282 (4.3)	325 (6.3)	390 (18.2)	550 (22.1)
Sweden	420 (9.4)	495 (4.3)	551 (4.2)	617 (5.5)	724 (9.2)
Switzerland	375 (10.6)	459 (6.9)	521 (5.0)	584 (4.9)	681 (9.2)
United States	332 (8.0)	416 (4.6)	477 (3.3)	541 (4.9)	640 (8.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.4

Percentiles of Achievement in Advanced Mathematics
Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	337 (30.1)	456 (17.5)	530 (9.0)	597 (10.4)	692 (21.1)
Austria	283 (15.2)	379 (11.4)	443 (7.9)	497 (8.8)	577 (16.4)
Canada	352 (7.1)	443 (5.4)	508 (4.8)	576 (7.2)	676 (10.1)
Cyprus	371 (23.0)	465 (5.7)	523 (10.4)	574 (5.2)	651 (15.8)
Czech Republic	320 (12.7)	399 (9.2)	454 (10.4)	524 (15.6)	665 (20.2)
Denmark	403 (5.6)	474 (3.8)	523 (2.3)	572 (4.8)	643 (6.9)
France	439 (5.5)	511 (5.1)	558 (5.5)	603 (6.4)	673 (8.4)
Germany	328 (9.3)	408 (8.0)	463 (5.7)	522 (5.6)	605 (6.9)
Greece	321 (35.1)	454 (11.6)	521 (6.4)	585 (5.1)	668 (12.7)
Italy	314 (14.9)	419 (13.4)	477 (10.3)	534 (8.3)	622 (22.7)
Lithuania	388 (12.2)	461 (5.5)	512 (3.6)	567 (3.3)	666 (16.9)
Russian Federation	360 (9.3)	465 (9.3)	539 (12.7)	618 (9.4)	730 (22.4)
Slovenia	330 (10.2)	408 (9.5)	473 (10.1)	537 (8.5)	630 (20.4)
Sweden	375 (7.9)	458 (10.5)	513 (11.4)	568 (7.0)	653 (13.6)
Switzerland	401 (5.6)	473 (6.2)	525 (7.9)	587 (5.9)	691 (3.4)
United States	292 (3.8)	375 (7.1)	437 (6.4)	504 (6.1)	609 (8.9)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.5

Percentiles of Achievement in Physics
Final Year of Secondary School*

Country	5th Percentile	25th Percentile	50th Percentile	75th Percentile	95th Percentile
Australia	386 (11.8)	461 (3.3)	517 (6.6)	570 (8.5)	656 (11.9)
Austria	306 (11.9)	379 (11.3)	427 (5.9)	486 (10.1)	581 (22.3)
Canada	346 (5.1)	429 (2.9)	482 (4.4)	539 (7.3)	633 (14.3)
Cyprus	325 (8.0)	434 (10.9)	487 (4.9)	551 (9.0)	681 (28.8)
Czech Republic	337 (4.5)	397 (6.2)	440 (6.6)	493 (12.3)	605 (29.5)
Denmark	397 (8.4)	478 (4.3)	535 (5.9)	588 (6.1)	677 (15.2)
France	358 (9.4)	423 (6.8)	465 (4.1)	509 (3.1)	574 (8.3)
Germany	374 (13.2)	458 (16.2)	519 (12.0)	580 (19.1)	688 (10.1)
Greece	333 (18.9)	431 (5.7)	495 (7.7)	545 (6.3)	619 (8.2)
Latvia (LSS)	348 (12.2)	418 (15.7)	474 (19.2)	540 (36.5)	687 (31.5)
Norway	432 (6.3)	517 (11.1)	578 (6.3)	646 (7.2)	727 (6.1)
Russian Federation	368 (18.2)	468 (15.7)	544 (12.6)	619 (16.5)	722 (21.2)
Slovenia	332 (11.3)	457 (15.3)	528 (21.2)	598 (14.1)	689 (36.3)
Sweden	422 (12.2)	511 (8.9)	574 (6.6)	634 (6.6)	725 (6.7)
Switzerland	353 (20.6)	430 (7.6)	479 (4.7)	540 (5.2)	648 (9.9)
United States	331 (4.7)	384 (4.0)	420 (4.2)	458 (6.4)	520 (6.6)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

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

( ) Standard errors appear in parentheses.

Table E.6

Standard Deviations of Achievement in Mathematics and Science Literacy
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	525 (9.5)	95 (4.8)	511 (9.3)	89 (5.4)	543 (10.7)	100 (5.8)
Austria	519 (5.4)	80 (3.1)	502 (5.5)	71 (3.2)	549 (7.8)	85 (4.5)
Canada	526 (2.6)	83 (1.6)	511 (3.4)	79 (1.9)	544 (3.4)	84 (2.2)
Cyprus	447 (2.5)	73 (2.3)	439 (3.0)	67 (2.9)	456 (4.9)	78 (3.9)
Czech Republic	476 (10.5)	92 (3.3)	452 (13.8)	84 (3.7)	500 (9.9)	93 (3.5)
Denmark	528 (3.2)	81 (2.3)	507 (3.7)	76 (2.5)	554 (4.5)	80 (3.0)
France	505 (4.9)	74 (2.7)	487 (4.8)	68 (2.6)	526 (5.9)	75 (3.6)
Germany	496 (5.4)	89 (3.2)	479 (8.5)	89 (4.6)	512 (8.2)	86 (4.0)
Hungary	477 (3.0)	84 (2.4)	468 (4.5)	76 (2.3)	485 (4.5)	91 (3.0)
Iceland	541 (1.6)	77 (1.2)	522 (1.9)	72 (1.3)	565 (2.9)	77 (2.0)
Italy	475 (5.3)	83 (4.0)	461 (5.7)	78 (5.0)	492 (6.9)	86 (4.8)
Lithuania	465 (5.8)	80 (3.3)	456 (7.4)	81 (3.5)	483 (6.7)	76 (3.3)
Netherlands	559 (4.9)	84 (4.0)	533 (5.9)	82 (4.7)	584 (5.5)	78 (4.2)
New Zealand	525 (4.7)	92 (2.4)	511 (5.5)	85 (3.1)	540 (5.7)	97 (3.3)
Norway	536 (4.0)	88 (2.1)	507 (4.5)	76 (2.6)	564 (5.0)	89 (3.1)
Russian Federation	476 (5.8)	83 (2.9)	462 (6.5)	81 (3.6)	499 (5.9)	81 (3.3)
Slovenia	514 (8.2)	82 (4.4)	492 (7.1)	73 (3.8)	538 (12.6)	84 (8.3)
South Africa	352 (9.3)	88 (8.7)	341 (11.8)	87 (13.6)	366 (10.3)	88 (8.4)
Sweden	555 (4.3)	91 (2.2)	533 (3.6)	80 (2.2)	579 (5.8)	96 (2.8)
Switzerland	531 (5.4)	88 (2.6)	511 (7.5)	85 (2.9)	547 (6.0)	87 (3.4)
United States	471 (3.1)	89 (2.1)	462 (3.5)	85 (3.0)	479 (4.2)	93 (2.4)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.7

Standard Deviations of Achievement in Mathematics Literacy
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	522 (9.3)	97 (4.9)	510 (9.3)	91 (5.1)	540 (10.3)	103 (6.1)
Austria	518 (5.3)	80 (2.8)	503 (5.5)	73 (2.9)	545 (7.2)	82 (4.1)
Canada	519 (2.8)	90 (1.7)	504 (3.5)	87 (2.6)	537 (3.8)	91 (2.7)
Cyprus	446 (2.5)	73 (2.6)	439 (3.7)	68 (2.9)	454 (4.9)	78 (4.0)
Czech Republic	466 (12.3)	99 (3.5)	443 (16.8)	92 (3.6)	488 (11.3)	101 (4.0)
Denmark	547 (3.3)	87 (2.8)	523 (4.0)	82 (2.6)	575 (4.0)	84 (3.8)
France	523 (5.1)	79 (2.8)	506 (5.3)	75 (2.8)	544 (5.6)	79 (3.6)
Germany	495 (5.9)	94 (3.2)	480 (8.8)	94 (4.5)	509 (8.7)	91 (4.4)
Hungary	483 (3.2)	92 (2.2)	481 (4.8)	85 (2.3)	485 (4.9)	99 (3.0)
Iceland	534 (2.0)	88 (1.4)	514 (2.2)	84 (1.2)	558 (3.4)	86 (2.4)
Italy	476 (5.5)	87 (3.9)	464 (6.0)	84 (5.2)	490 (7.4)	90 (5.0)
Lithuania	469 (6.1)	85 (3.5)	461 (7.7)	86 (3.6)	485 (7.3)	80 (4.2)
Netherlands	560 (4.7)	90 (3.5)	533 (5.9)	90 (4.4)	585 (5.6)	82 (3.8)
New Zealand	522 (4.5)	98 (2.2)	507 (6.2)	93 (3.0)	536 (4.9)	101 (3.0)
Norway	528 (4.1)	94 (1.9)	501 (4.8)	84 (2.5)	555 (5.3)	95 (2.9)
Russian Federation	471 (6.2)	85 (3.2)	460 (6.6)	84 (3.9)	488 (6.5)	86 (3.5)
Slovenia	512 (8.3)	87 (4.4)	490 (8.0)	79 (4.6)	535 (12.7)	87 (8.9)
South Africa	356 (8.3)	81 (8.5)	348 (10.8)	80 (13.3)	365 (9.3)	83 (8.2)
Sweden	552 (4.3)	99 (2.3)	531 (3.9)	89 (2.4)	573 (5.9)	103 (3.1)
Switzerland	540 (5.8)	88 (2.5)	522 (7.4)	86 (2.9)	555 (6.4)	88 (3.6)
United States	461 (3.2)	91 (1.9)	456 (3.6)	88 (2.6)	466 (4.1)	94 (2.6)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.8

Standard Deviations of Achievement in Science Literacy
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	527 (9.8)	100 (5.0)	513 (9.4)	94 (5.9)	547 (11.5)	104 (5.6)
Austria	520 (5.6)	87 (3.6)	501 (5.8)	75 (3.4)	554 (8.7)	94 (5.0)
Canada	532 (2.6)	85 (1.9)	518 (3.8)	80 (2.2)	550 (3.6)	86 (2.2)
Cyprus	448 (3.0)	83 (2.7)	439 (3.0)	76 (3.6)	459 (5.8)	88 (4.6)
Czech Republic	487 (8.8)	91 (3.0)	460 (11.0)	84 (3.6)	512 (8.8)	91 (3.2)
Denmark	509 (3.6)	87 (2.4)	490 (4.1)	82 (2.8)	532 (5.4)	87 (3.3)
France	487 (5.1)	79 (2.4)	468 (4.8)	71 (2.4)	508 (6.7)	81 (3.4)
Germany	497 (5.1)	91 (3.5)	478 (8.5)	91 (4.7)	514 (7.9)	87 (3.9)
Hungary	471 (3.0)	86 (2.5)	455 (4.3)	78 (2.3)	484 (4.2)	91 (3.0)
Iceland	549 (1.5)	75 (1.4)	530 (2.1)	69 (1.8)	572 (2.7)	76 (1.9)
Italy	475 (5.3)	87 (3.9)	458 (5.6)	81 (4.6)	495 (6.7)	89 (4.9)
Lithuania	461 (5.7)	84 (3.2)	450 (7.3)	84 (3.6)	481 (6.4)	79 (2.9)
Netherlands	558 (5.3)	86 (4.5)	532 (6.2)	82 (5.2)	582 (5.7)	82 (4.9)
New Zealand	529 (5.2)	94 (3.2)	515 (5.2)	87 (3.8)	543 (7.1)	100 (4.7)
Norway	544 (4.1)	91 (2.5)	513 (4.5)	79 (2.7)	574 (5.1)	93 (3.6)
Russian Federation	481 (5.7)	91 (2.8)	463 (6.7)	89 (3.2)	510 (5.7)	86 (3.7)
Slovenia	517 (8.2)	84 (4.7)	494 (6.4)	72 (3.4)	541 (12.7)	87 (7.8)
South Africa	349 (10.5)	100 (8.7)	333 (13.0)	100 (13.5)	367 (11.5)	98 (8.5)
Sweden	559 (4.4)	91 (2.2)	534 (3.5)	79 (2.2)	585 (5.9)	95 (2.8)
Switzerland	523 (5.3)	94 (2.7)	500 (7.8)	90 (3.4)	540 (6.1)	92 (3.3)
United States	480 (3.3)	94 (2.5)	469 (3.9)	89 (3.5)	492 (4.5)	98 (2.7)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.

( ) Standard errors appear in parentheses.

Table E.9

Standard Deviations of Achievement in Advanced Mathematics
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	525 (11.6)	109 (7.9)	517 (15.1)	110 (9.3)	531 (11.4)	108 (9.0)
Austria	436 (7.2)	91 (5.5)	406 (8.6)	87 (6.6)	486 (7.3)	76 (5.4)
Canada	509 (4.3)	98 (2.4)	489 (4.4)	89 (2.7)	528 (6.4)	103 (2.9)
Cyprus	518 (4.3)	85 (3.0)	509 (6.4)	77 (4.9)	524 (4.4)	90 (3.9)
Czech Republic	469 (11.2)	106 (9.3)	432 (8.9)	89 (6.4)	524 (13.0)	106 (12.0)
Denmark	522 (3.4)	73 (1.9)	510 (4.6)	68 (3.4)	529 (4.4)	76 (2.3)
France	557 (3.9)	70 (2.1)	543 (5.1)	67 (2.9)	567 (5.1)	70 (2.6)
Germany	465 (5.6)	85 (3.4)	452 (6.6)	81 (3.9)	484 (6.5)	86 (4.1)
Greece	513 (6.0)	105 (6.0)	505 (10.2)	88 (8.5)	516 (6.6)	111 (7.5)
Italy	474 (9.6)	95 (8.1)	460 (14.1)	95 (13.1)	484 (10.6)	94 (8.7)
Lithuania	516 (2.6)	85 (3.2)	490 (5.6)	78 (6.8)	542 (3.7)	84 (3.8)
Russian Federation	542 (9.2)	112 (5.6)	515 (10.2)	106 (8.0)	568 (9.7)	111 (4.4)
Slovenia	475 (9.2)	94 (3.8)	464 (11.0)	89 (3.5)	484 (11.5)	97 (5.4)
Sweden	512 (4.4)	86 (2.9)	496 (5.2)	78 (4.5)	519 (5.9)	88 (3.6)
Switzerland	533 (5.0)	90 (2.7)	503 (5.7)	77 (4.9)	559 (5.6)	93 (3.9)
United States	442 (5.9)	98 (4.1)	426 (7.1)	98 (5.6)	457 (7.8)	96 (4.8)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.
( ) Standard errors appear in parentheses.

Table E.10

Standard Deviations of Achievement in Physics
Final Year of Secondary School*

Country	Overall		Females		Males	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Australia	518 (6.2)	82 (3.6)	490 (8.4)	75 (5.3)	532 (6.7)	82 (5.6)
Austria	435 (6.4)	83 (4.6)	408 (7.4)	71 (5.9)	479 (8.1)	82 (5.7)
Canada	485 (3.3)	87 (3.0)	459 (6.3)	75 (3.9)	506 (6.0)	90 (4.2)
Cyprus	494 (5.8)	105 (5.3)	470 (7.1)	96 (7.9)	509 (8.9)	108 (7.9)
Czech Republic	451 (6.2)	82 (5.9)	419 (3.9)	63 (5.1)	503 (8.8)	83 (5.4)
Denmark	534 (4.2)	85 (3.9)	500 (8.1)	74 (6.8)	542 (5.2)	87 (4.4)
France	466 (3.8)	66 (3.1)	450 (5.6)	61 (3.2)	478 (4.2)	67 (4.4)
Germany	522 (11.9)	94 (5.3)	479 (9.1)	80 (5.3)	542 (14.3)	93 (6.9)
Greece	486 (5.6)	87 (3.7)	468 (8.1)	79 (6.9)	495 (6.1)	90 (5.0)
Latvia (LSS)	488 (21.5)	100 (10.6)	467 (22.6)	97 (11.4)	509 (19.0)	99 (11.5)
Norway	581 (6.5)	91 (2.5)	544 (9.3)	88 (4.5)	594 (6.3)	88 (2.5)
Russian Federation	545 (11.6)	110 (5.0)	509 (15.3)	108 (9.1)	575 (9.9)	103 (3.8)
Slovenia	523 (15.5)	109 (8.7)	455 (18.7)	106 (6.4)	546 (16.3)	99 (10.8)
Sweden	573 (3.9)	92 (2.8)	540 (5.3)	78 (4.8)	589 (5.1)	94 (3.7)
Switzerland	488 (3.5)	88 (2.9)	446 (3.6)	69 (2.9)	529 (5.2)	86 (4.0)
United States	423 (3.3)	60 (3.2)	405 (3.1)	53 (1.8)	439 (4.3)	62 (5.0)

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96.

* See Appendix A for characteristics of students sampled.
Because population coverage falls below 65%, Latvia is annotated LSS for Latvian Speaking Schools only.
( ) Standard errors appear in parentheses.

Appendix F

ACKNOWLEDGMENTS

TIMSS was truly a collaborative effort among hundreds of individuals around the world. Staff from the national research centers, the international management, advisors, and funding agencies worked closely to design and implement the most ambitious study of international comparative achievement ever undertaken. TIMSS would not have been possible without the tireless efforts of all involved. Below, the individuals and organizations are acknowledged for their contributions. Given that implementing TIMSS has spanned more than seven years and involved so many people and organizations, this list may not pay heed to all who contributed throughout the life of the project. Any omission is inadvertent. TIMSS also acknowledges the students, teachers, and school principals who contributed their time and effort to the study. This report would not be possible without them.

MANAGEMENT AND OPERATIONS

Since 1993, TIMSS has been directed by the International Study Center at Boston College in the United States. Prior to this, the study was coordinated by the International Coordinating Center at the University of British Columbia in Canada. Although the study was directed centrally by the International Study Center and its staff members implemented various parts of TIMSS, important activities also were carried out in centers around the world. The data were processed centrally by the IEA Data Processing Center in Hamburg, Germany. Statistics Canada was responsible for collecting and evaluating the sampling documentation from each country and for calculating the sampling weights. The Australian Council for Educational Research conducted the scaling of the achievement data.

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NATIONAL RESEARCH COORDINATORS

The TIMSS National Research Coordinators and their staff had the enormous task of implementing the TIMSS design in their countries. This required obtaining funding for the project; participating in the development of the instruments and procedures; conducting field tests; participating in and conducting training sessions; translating the instruments and procedural manuals into the local language; selecting the sample of schools and students; working with the schools to arrange for the testing; arranging for data collection, coding, and data entry; preparing the data files for submission to the IEA Data Processing Center; contributing to the development of the international reports; and preparing national reports. The way in which the national centers operated and the resources that were available varied considerably across the TIMSS countries. In some countries, the tasks were conducted centrally, while in others, various components were subcontracted to other organizations. In some countries, resources were more than adequate, while in others, the national centers were operating with limited resources. Of course, across the life of the project, some NRCs have changed. This list attempts to include all past NRCs who served for a significant period of time as well as all the present NRCs. All of the TIMSS National Research Coordinators and their staff members are to be commended for their professionalism and their dedication in conducting all aspects of TIMSS.

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The TIMSS International Study Center was supported in its work by several advisory committees. The TIMSS International Steering Committee provided guidance to the International Study Director on policy issues and general direction of the study. The TIMSS Technical Advisory Committee provided guidance on issues related to design, sampling, instrument construction, analysis, and reporting, ensuring that the TIMSS methodologies and procedures were technically sound. The Subject Matter Advisory Committee ensured that current thinking in mathematics and science education were addressed by TIMSS, and was instrumental in the development of the TIMSS tests. The Free-Response Item Coding Committee developed the coding rubrics for the free-response items. The Performance Assessment Committee worked with the Performance Assessment Coordinator to develop the TIMSS performance assessment. The Quality Assurance Committee helped to develop the quality assurance program.

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