Executive Summary

Mathematics and Science Achievement in the Final Year of Secondary School

Since its inception in 1959, the International Association for the Evaluation of Educational Achievement (IEA) has conducted a series of international comparative studies designed to provide policy makers, educators, researchers, and practitioners with information about educational achievement and learning contexts. The Third International Mathematics and Science Study (TIMSS) is the largest and most ambitious of these studies.

The scope and complexity of TIMSS is enormous. The mathematics and science testing covered five different grade levels, with more than 40 countries collecting data in more than 30 different languages. More than half a million students were tested around the world. The present report contains the results for students in the final year of secondary school.

As can be imagined, testing this "grade" was a special challenge for TIMSS. The 24 countries participating in this component of the testing vary greatly with respect to the nature of their upper secondary education systems. First, there was the question of how many students of the age-eligible cohort are even in school by the final year, and how this might differ across countries. Second, it was no small task for many countries to describe the final year of school. In most TIMSS countries, students' final year of school depends on their course of study (e.g., academic, technical, or apprenticeship). Thus, the final year of schooling varies across and within countries, with some students completing secondary school after a two-, three-, four-, or even five-year program. Understandably, it was difficult for some countries to test all of the final-year students, particularly the ones in on-site occupational training. To give some indication of the proportion of the entire school-leaving age cohort that was covered by the testing in each country, TIMSS developed its own index – the TIMSS Coverage Index or TCI. In general, the smaller the TCI, the more elite the group of students tested.

Given the extensive diversity of students' curricula there also were many questions about what mathematics and science understandings students should have to meet the challenges beyond secondary school. Thus, TIMSS developed three different tests. The mathematics and science literacy test was designed for all final-year students, regardless of their school curriculum. By and large, the purpose of this test was to measure how well students can use their knowledge in addressing real-world problems having a mathematics or science component. This test was designed to be reported separately for mathematics and for science. There also was great interest on the part of some TIMSS countries to determine what school-leaving students with special preparation in mathematics and science know and can do, since the capabilities of these students may help determine a country's future potential to compete in a global economy. Thus, a second test was developed for students having taken advanced mathematics. For the sciences, it was not possible to study all branches of science in detail. The participating countries chose physics for detailed study because it is the branch of science most closely associated with mathematics, and came closest to embodying the essential elements of natural science. The third test, then, was a physics test designed to measure learning of physics concepts and knowledge among final-year students having studied physics. Each of the three tests contains multiple-choice questions as well as questions in an open-ended format requiring students to generate and write their answers. These types of questions, some of which required extended responses, were allotted approximately one-third of the testing time. Not all of the 24 countries participated in the three different parts of the testing (see Table 1).

The success of TIMSS depended on a collaborative effort between the research centers in each country responsible for implementing the steps of the project and the network of centers responsible for managing the across-country tasks such as training country representatives in standardized procedures, selecting comparable samples of schools and students, and conducting the various steps required for data processing and analysis. Most countries tested the mathematics and science achievement of their students in May and June of 1995.

TIMSS was conducted with attention to quality at every step of the way. Rigorous procedures were designed specifically to translate the tests, and numerous regional training sessions were held in data collection and scoring procedures. Quality control monitors observed testing sessions, and sent reports back to the TIMSS International Study Center at Boston College. The samples of students selected for testing were scrutinized according to rigorous standards designed to prevent bias and ensure comparability. In this publication, the countries are grouped for reporting of achievement according to their compliance with the sampling guidelines and the level of their participation rates. Prior to analysis, the data from each country were subjected to exhaustive checks for adherence to the international formats as well as for within-country consistency and comparability across countries.

The results for the students in their final year of secondary school complete the first round of descriptive reports from the TIMSS study. Together with the results for primary school students (third and fourth grades in most countries) and middle school students (seventh and eighth grades in most countries), the results contained herein will provide valuable information about the relative effectiveness of a country’s education system as students progress through school.

The following sections summarize the major findings described in this report.

Mathematics and Science Literacy

The report presents mathematics and science literacy achievement results for 21 countries. Even though there was quite a range in the TCIs, about half the countries were able to cover 70% or more of the entire school-leaving age cohort (see Table 1.1). Also, contrary to some previous international studies, for the mathematics and science literacy testing, the higher-performing countries tended to have better coverage than the lower-performing countries. Although differing levels of selectivity among education systems was not a large issue, low student participation rates were a problem in many of the countries. Because final-year students have many demands on their time and their educational situations can make testing difficult (e.g., apprenticeship training), countries had some difficulty in encouraging students to attend the testing sessions. Only eight countries met the TIMSS guidelines for sample participation (see Table 1.1).

- The Netherlands and Sweden were the top-performing countries. Iceland, Norway, and Switzerland also performed well, similar to each other but significantly below the Netherlands and Sweden. Other countries performing above the international average of the 21 countries were Denmark, Canada, New Zealand, and Austria. [The only two high-performing countries with a low degree of coverage of the school-leaving age cohort (less than 60%) were Denmark and Iceland. However, of the high-performing countries, only Sweden, Switzerland, and New Zealand met the sampling guidelines. The Netherlands and Denmark deviated from the approved sampling procedures and had low participation rates.]

- Countries performing below the international average were (in descending order of average achievement): Hungary, the Russian Federation, Italy, the United States, Lithuania, Cyprus, and South Africa. In general, Hungary, the Russian Federation, Italy, the United States, and Lithuania performed similarly, followed by Cyprus and South Africa.

- As noted above, selectivity in education systems and sampling approaches did not seem to be much of a factor in the mathematics and science literacy testing. Still, to place countries on a more equal footing, it is interesting to look at performance for the top 25% of the students in the entire school-leaving age cohort. From this perspective, Sweden, the Netherlands, Norway, and Switzerland were the highest performing countries.

- When the results were looked at separately for mathematics and science, the top-performers in mathematics literacy were the Netherlands, Sweden, Denmark, and Switzerland. The top-performers in science literacy were Sweden, the Netherlands, Iceland, and Norway.

- Countries that had higher achievement in mathematics literacy than in science literacy were Denmark, France, Hungary, Lithuania, and Switzerland. Those with higher achievement in science literacy were Canada, the Czech Republic, Iceland, Norway, the Russian Federation, Sweden, and the United States.

- In all countries except South Africa, males had significantly higher average achievement than females in mathematics and science literacy. This also was true for science literacy. In mathematics literacy, there were no significant gender differences in performance in Hungary, the United States, and South Africa.

- Countries ranking high in mathematics achievement at the eighth grade did not always rank high in mathematics literacy at the upper secondary level. Only five countries were above the international average both at the eighth grade and for their upper secondary school students: Switzerland, the Netherlands, Austria, France, and Canada.

- In general, the students no longer taking mathematics performed less well in mathematics literacy than those still studying the subject. Similarly, there was a positive association between taking science subjects and performance in science literacy in almost every country.

- In nine countries (Australia, Cyprus, the Czech Republic, France, Hungary, Italy, Lithuania, the Russian Federation, and Slovenia), 85% or more of the students reported that they were currently taking mathematics. In contrast, countries where as many as one-third of the final-year students reported that they were not currently taking mathematics included Canada, Iceland, the Netherlands, Switzerland, and the United States.

- Compared with mathematics, higher percentages of students in most countries reported that they were taking no science subject at the time of testing. Half or more of the students in the Czech Republic, Denmark, Norway, Sweden, and Switzerland, reported that they were not taking science, and nearly half of the final-year students so reported in Canada and the United States.

- Even though a strictly comparable classification of educational programs was not always possible across countries, students enrolled in academic programs had higher average achievement than students in vocational programs. The average achievement of students in technical programs generally was somewhere between that of the academic and vocational students.

- Students generally reported positive perceptions about their performance in mathematics and science. The highest perceptions of success in mathematics were reported in Australia, Denmark, Italy, and the United States, where 70% or more of the students agreed that they usually did well. Perceptions of doing well in science were generally higher; in 12 countries more than 70% of the students agreed that they usually did well. Eighty percent or more so agreed in Italy, Lithuania, and the United States.

- Despite the different educational approaches, structures, and organizations across the TIMSS countries, it is clear that parents' education is positively related to students' mathematics and science literacy. As was the case for eighth graders, in every country final-year students whose parents had more education had higher mathematics and science literacy.

- More than 30% of students in Canada, Iceland, Lithuania, the Russian Federation, and the United States indicated that at least one parent had finished university, while in contrast, more than 30% of the students in Australia, Cyprus, the Czech Republic, France, Italy, and South Africa reported that the highest level attained by either parent was finished primary but not upper secondary school.

- In most countries, more than 80% of the students reported at least weekly use of calculators (at school, at home, or anywhere else). Only in the Czech Republic, Norway, and the Russian Federation did 20% or more of the students report rarely or never using calculators. The frequent use of calculators was positively related to mathematics and science literacy in all countries.

- Final-year students were given the option of using a calculator when completing the TIMSS tests. Most students made moderate use of a calculator on the mathematics and science literacy test. The students who reported the most calculator use on the test performed best.

- The final-year students in a number of countries reported relatively infrequent computer use (at school, at home or anywhere else). Only in Australia, Austria, Canada, Denmark, Iceland, the Netherlands, New Zealand, Switzerland, and the United States did more than 50% of the students report at least weekly use of computers.

- Students in most countries reported spending between two and three hours per day on homework, on average. One-fourth or more of the final-year students in Austria, the Czech Republic, the Netherlands, Norway, Sweden, Switzerland, and the United States reported studying for less than one hour per day.

- Students were also asked about other ways they could spend their time out of school. Socializing is clearly an important activity for final-year students, with students in many countries devoting up to about two and one-half hours each day to spending time with friends. Watching television or videos also is a frequent activity (about an hour or so a day).

- Students' reports about the time spent working at a paid job varied across countries. In about half the countries, most final-year students (more than 80%) reported working at a paid job for less than one hour each day. However, in Australia, Canada, Iceland, the Netherlands, New Zealand, Norway, and the United States, at least one-fourth of the students reported working for three hours or more each day.

Advanced Mathematics

The report presents results for 16 countries participating in the testing of students having taken advanced mathematics courses. The test questions covered primarily the content areas of equations and functions, calculus, and geometry, and results are provided overall as well as separately for these three areas. The percentages of students tested in each country reflect the fact that a relatively small subset of the final-year students in each country have taken the advanced mathematics courses necessary to participate in this portion of the testing. The percentages of the school-leaving age cohort covered by the sample of students tested in advanced mathematics in each country ranged dramatically, although most countries tested 20% or less of this cohort. Countries with coverage below 10% were the Russian Federation (2%), Lithuania (3%), and Cyprus (9%). Austria (33%) and particularly Slovenia (75%) were at the high end. Compared to the mathematics and science literacy testing, countries had more success in locating these advanced students and encouraging them to participate in the testing. Thus, 10 of the 16 countries met the TIMSS sampling guidelines (see Table 5.1).

- Led by France, the countries performing above the international average of the 16 countries also included the Russian Federation, Switzerland, Denmark, Cyprus, and Lithuania. Australia, Greece, Sweden, and Canada also performed similarly to several countries in this top group. [Among these countries, the Russian Federation and Lithuania tested a very small percentage (2-3%) of their school-leaving age cohort. Denmark did not meet the TIMSS guidelines for either sampling procedures or participation rates, and Australia had school participation rates below the required 85%.]

- The cluster of lower-performing countries included Slovenia, Italy, the Czech Republic, Germany, the United States, and Austria. All except Slovenia and Italy performed below the international average.

- Interestingly, looking at the top 10% of the school-leaving age cohort, Slovenia and France had significantly higher performance than other participating countries. Even though Slovenia had difficulty in implementing the TIMSS sampling guidelines, the advanced mathematics testing covered three-fourths of its entire school-leaving age cohort. Similarly, France followed all of the sampling guidelines and also had relatively high coverage (20%). It appears that having higher percentages of students enrolled in advanced mathematics courses need not have a negative impact on the performance of the top students in that group.

- Significant gender differences favoring males in advanced mathematics achievement were found in all countries except Greece, Cyprus, Australia, Italy, and Slovenia. In some countries many more males than females have taken advanced mathematics courses, but this varied across countries.

- Compared to the other participating countries, most countries showed particular strengths or weaknesses in the content areas tested. For example, Sweden performed above the international average in numbers and equations, below the international average in calculus, and about at the international average in geometry.

- Most countries also did relatively better in some content areas than others compared to their overall performance in advanced mathematics. For example, compared to their overall average achievement, students in the United States performed better in numbers and equations and worse in geometry.

- Although the majority of students in many TIMSS countries reported receiving from three to five hours of mathematics instruction each week, in Austria and Sweden more than 60% of the students had less than three hours each week, and in Australia, Canada, Cyprus, France, Greece, and the Russian Federation, the majority of students had five hours or more.

- The amount of homework assigned also varied considerably. At one extreme, more the 40% of the advanced mathematics students in the Czech Republic and Sweden reported that they were assigned mathematics homework less than once a week, while at the other extreme, more than 80% of the students in Australia, Canada, Cyprus, Greece, Lithuania, the Russian Federation, and the United States reported having homework assigned three or more times a week.

- Advanced mathematics students were asked how often several different types of instructional activities were used in their classrooms. Among these, almost all students in all countries reported being asked to do reasoning tasks in at least some lessons. In almost every country, the students with the highest achievement were those that reported engaging in reasoning tasks most frequently.

- Algebra is an essential component of mathematics in upper secondary school, and students in every country reported that they are often asked to solve equations in mathematics class. Spending time working on equations also was an indicator of high achievement on the TIMSS advanced mathematics test.

- Final-year advanced mathematics students reported that the use of computers to do exercises or solve problems in mathematics class is comparatively rare.

- Calculator use by final-year advanced mathematics students was very common. In Australia, Canada, Cyprus, Denmark, Sweden, and the United States, more than 80% of the students reported using a calculator daily (at home, at school, or anywhere else), and in several other countries more than half of the students reported this level of use. In general, the advanced mathematics students with the highest average achievement were those who reported the highest level of calculator use.

- Most of the advanced mathematics students made moderate use of a calculator on the TIMSS test. In general, the students who reported that they did not use a calculator on the advanced mathematics test did not do as well as those who reported using one, although the extent of calculator use was not consistently related to achievement in every country.

- Among the final-year students taking advanced mathematics, the majority in every country reported that they plan to attend university. When asked about their plans for areas of future study, the most popular choices were business, health sciences or related occupations, and engineering.

- Even though not many students chose mathematics as their preferred area of future study, the majority of the students in many of the countries agreed that they would like a job that involved using mathematics. In general, more males than females agreed that they would like a job involving mathematics.

Physics

Physics achievement results for students having taken physics are reported for 16 countries. The physics test was designed to measure five content areas: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle, quantum and astrophysics, and relativity. The percentage of the entire school-leaving age cohort that participated in the physics study was approximately 15% in several countries, although it varied from as little as 2% to 3% in the Russian Federation, Latvia (LSS), and Denmark to 33% in Austria and 39% in Slovenia. Eleven of the countries met the TIMSS sampling guidelines (see Table 8.1).

- Norway and Sweden had average physics achievement similar to each other and significantly higher than the other participating countries. The Russian Federation and Denmark also performed above the international average. [The Russian Federation had a very low coverage index (2%) as did Denmark (3%), and Denmark did not comply with the guidelines for sampling procedures or participation rates.]

- The cluster of lowest-performing countries included France, the Czech Republic, Austria, and the United States, all of which performed below the international average of the 16 countries.

- The country rankings for the top 10% of the school-leaving age cohort were quite consistent with those obtained from all the tested students. However, the countries most likely to improve their standing were those with the largest coverage index, since they were least likely to have tested just the elite students. Slovenia joined Sweden as a top-performer, despite having difficulties with low sampling participation and unapproved sampling procedures. Austria also moved from the lowest-scoring cluster of countries to the middle group.

- Males had significantly higher physics achievement than females in all but one of the participating countries (Latvia (LSS)). Although the proportions of males and females taking physics were about equal in Latvia (LSS), Canada, the Russian Federation, Switzerland, and the United States, in several countries males outnumbered females by two or three to one.

- Norway and Sweden performed above the international average in all five physics content areas, while Austria and the United States fell below the international average in all five. Nearly every other country scored significantly above or below the international average in at least one content area, and about average in the others.

- Compared to their overall physics performance, most countries did relatively better in some content areas than others. For example, students in Canada performed relatively less well in mechanics and relatively better in heat than they did on the physics test as a whole.

- Significant gender differences favoring males were found in more countries in the areas of mechanics (15 countries), wave phenomena (11 countries), and modern physics (12 countries) than in electricity and magnetism (8 countries) or heat (7 countries).

- The amount of physics instruction received by students varied considerably across countries, but in general was less than five hours per week. The assignment of homework also varied considerably from less than once a week in several countries to three or more times a week in others.

- Although laboratory work might be expected to play a central role in physics classes, students reports varied across countries. In Austria, Germany, and Greece, the majority of the students reported that they never or almost never conduct laboratory experiments, whereas one-fourth or more of the students in Canada, Cyprus, Denmark, France, Switzerland, and the United States reported conducting experiments in most or all lessons. In about half the countries, the majority of students reported conducting experiments in some lessons. There was no consistent relationship between frequency of conducting laboratory experiments in class and physics achievement.

- Paralleling the findings for advanced mathematics, physics students frequently use calculators. Although the relationship was less pronounced than for students having taken advanced mathematics, in most countries students who reported daily calculator use performed better on the TIMSS physics test than those who reported less frequent use.

- Students were given the option of using a calculator when completing the physics test, and most physics students in every country used the calculator on some questions. The extent of calculator use was not consistently related to achievement in every country, but physics students who reported that they did not use a calculator on the test did less well than those who reported using one.

- Like the plans for further education of final-year students having taken advanced mathematics, those of final-year physics students center mainly on university. Students who have studied physics are well positioned to continue their education in the sciences or in areas of scientific application. Although choice of future study area varied considerably across countries, the most popular were engineering, mathematics or computer/information sciences, health sciences or related occupations, and business. While more females than males chose health sciences or related occupations, males often outnumbered females by a substantial margin in engineering, and in mathematics or computer/information sciences.

Introduction

Mathematics and Science Achievement in the Final year of Secondary School

Several major educational issues are addressed by the secondary school assessment conducted as part of the Third International Mathematics and Science Study (TIMSS). One such issue is how effective educational systems around the world have been in educating their whole populations rather than just an elite group of students. Given the importance of an understanding of mathematics and science to social and economic participation in a technology-based society, there is particular interest in what students finishing secondary school know and can do in mathematics and science; that is, after studying mathematics and science during their years as students, how literate are they in these subjects?

There is also special interest in what school-leaving students with special preparation in advanced mathematics and physics, the potential future mathematics and science specialists, know and can do in these subjects. The achievement of these students may indicate the ability of countries to compete in a global economy based on scientific discoveries, state-of-the-art approaches to financing, and innovations in electronics, computing applications, and fast-paced communication technologies.

Both for the overall school population and for students having taken advanced mathematics and physics, the TIMSS data for final-year students can be used to help determine what understanding of mathematics and science concepts students have after completing their upper secondary schooling, and how effectively they might use that understanding as they move on to their future endeavors in school, occupational, and community settings. Beyond providing the participating countries with a solid basis for examining their students' performance from an international perspective, TIMSS gives each of them an impetus for scrutinizing the quality and effectiveness of its education system.

Together with the previously released results in mathematics and science achievement for primary and middle school students, the TIMSS results for students in the final year of secondary school can heighten countries' awareness of a myriad of educational issues. By expanding each country's knowledge of what is possible through learning about the achievements of others and the techniques they use, TIMSS affords the participants unprecedented opportunity to consider the most-needed reforms and to garner public support for improving students' learning in mathematics and science.

TIMSS is the most ambitious and complex comparative education study in a series of such undertakings conducted during the past 37 years by the International Association for the Evaluation of Educational Achievement (IEA).[1] The main purpose of TIMSS was to focus on educational policies, practices, and outcomes

[1] The previous IEA mathematics studies were conducted in 1964 and 1980-82, and the science studies in 1970-71 and 1983-84. For information about TIMSS procedures, see Appendix B.

in order to enhance mathematics and science learning within and across systems of education. With its wealth of information from more than half a million students at five grade levels in 15,000 schools and 41 countries, TIMSS enables the participants to examine similarities and differences in how mathematics and science education works and how well it works. The study used innovative testing approaches and collected extensive information about the contexts within which students learn mathematics and science.

All countries that participated in TIMSS were to test students in the two grades with the largest proportion of 13-year-olds (seventh and eighth grades in most countries) in both mathematics and science. Many TIMSS countries also tested the mathematics and science achievement of students in the two grades with the largest proportion of 9-year-olds (third and fourth grades in most countries) and of students in their final year of secondary education. Subsets of students in the fourth and eighth grades also had the opportunity to participate in a “hands-on” performance assessment.

Together with the achievement tests, TIMSS administered a broad array of background questionnaires. The data collected from students, teachers, and school principals, as well as the system-level information collected from the participating countries, provide an abundance of information for further study and research. TIMSS data make it possible to examine differences in current levels of performance in relation to a wide variety of variables associated with the classroom, school, and national contexts within which education takes place.

The results of the assessments of primary and middle school students have been published in:

Mathematics Achievement in the Primary School Years: IEA’s Third International Mathematics and Science Study[2]

Science Achievement in the Primary School Years: IEA’s Third International Mathematics and Science Study[3]

Mathematics Achievement in the Middle School Years: IEA’s Third International Mathematics and Science Study[4]

[2] Mullis, I.V.S., Martin, M.O., Beaton, A.E., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1997). *Mathematics Achievement in the Primary School Years: IEA’s Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[3] Martin, M.O., Mullis, I.V.S., Beaton, A.E., Gonzalez, E.J., Smith, T.A., and Kelly, D.L. (1997). *Science Achievement in the Primary School Years: IEA’s Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[4] Beaton, A.E., Mullis, I.V.S., Martin, M.O., Gonzalez, E.J., Kelly, D.L., and Smith, T.A. (1996). *Mathematics Achievement in the Middle School Years: IEA’s Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study[5]

Performance Assessment in IEA's Third International Mathematics and Science Study[6]

These reports have been widely disseminated and are available on the internet (http://wwwcsteep.bc.edu/timss). The entire TIMSS international database containing the achievement and background data underlying these reports also has been released and is available at the TIMSS website.

The present report focuses on the mathematics and science literacy of all students in their final year of upper secondary school, and on the advanced mathematics and physics achievement of final-year students who have taken advanced courses in those subjects. The TIMSS International Study Center also plans to make the data collected in the final-year assessment available at its website, together with this report.

What Assessments Were Conducted and Which Students Were Tested?

The **mathematics and science literacy test** was designed to measure the mathematics and science learning of all final-year students who are at the point of leaving school and entering the workforce or postsecondary education, regardless of their school curriculum. These students may have specialized in mathematics and science in secondary school or have concentrated their studies in other areas, depending on the curricula offered in the participating countries. The mathematics and science literacy study is designed to provide information about how prepared the overall population of school leavers in each country is to apply knowledge in mathematics and science to meet the challenges of life beyond school.

The **advanced mathematics test** was designed to measure learning of advanced mathematics concepts among final-year students who have studied advanced mathematics. These students are at the point of leaving secondary school, and many will go on to further education in university or to another form of postsecondary education. Many of the mathematicians, scientists, engineers, medical practitioners, and business leaders of the future will be drawn from this group. In all countries that participated in the advanced mathematics assessment, the subpopulation of students tested had taken courses in advanced mathematics and was in the final year of secondary school at the time of testing. The exact definition of the subpopulation tested, however,

[5] Beaton, A.E., Martin, M.O., Mullis, I.V.S., Gonzalez, E.J., Smith, T.A., and Kelly, D.L. (1996). *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

[6] Harmon, M., Smith,T.A., Martin, M.O., Kelly, D.L., Beaton, A.E., Mullis, I.V.S., Gonzalez, E.J., and Orpwood, G. (1997). *Performance Assessment in IEA's Third International Mathematics and Science Study (TIMSS).* Chestnut Hill, MA: Boston College.

varied across countries in terms of which courses and how much advanced mathematics the students had taken (see Appendix A for more details). In addition to reporting achievement in advanced mathematics overall, this report presents achievement in three advanced mathematics content areas: numbers and equations; calculus; and geometry.

The **physics test** was designed to measure learning of physics concepts and knowledge among final-year students who have studied physics. These students too are about to leave secondary school, and many will go on to university or other postsecondary education. The physics study was designed to provide information about how prepared the population of school leavers that has taken physics is to pursue higher education or occupations in science. In all countries the students participating in the physics testing had taken physics and were in the final year of secondary school at the time of testing, but the exact definition of the population varied across countries in terms of which courses and how much physics the students had taken (see Appendix A for more details). In addition to reporting achievement in physics overall, this report presents achievement in five physics content areas: mechanics; electricity and magnetism; heat; wave phenomena; and modern physics – particle physics, quantum and astrophysics, and relativity.

Which Countries Participated?

Table 1 shows the countries that participated in the assessment of students in their final year of secondary school in mathematics and science literacy, advanced mathematics, and physics. Each participating country designated a national center to conduct the activities of the study and a National Research Coordinator (NRC) to assume responsibility for the successful completion of these tasks.[7] For the sake of comparability, all testing was conducted at the end of the school year. Most countries tested the mathematics and science achievement of their students at the end of the 1994-95 school year, most often in May and June of 1995. The three countries on a Southern Hemisphere school schedule (Australia, New Zealand, and South Africa) tested from August to December 1995, which was late in the school year in the Southern Hemisphere. Students in Australia were tested in September to October; students in New Zealand were tested in August; and students in South Africa were tested in August to December 1995. Three countries tested their final-year students (or a subset of them) at the end of the 1995-96 school year. Iceland tested its final-year students in 1996; Germany tested its gymnasium students in 1996; and Lithuania tested the students in vocational schools in 1996. In Germany and Lithuania, all other students included in the TIMSS assessment were tested in 1995.

[7] Appendix F lists the National Research Coordinators as well as the members of the TIMSS advisory committees.

Table 1

Countries Participating in Testing of Students in Their Final Year of Secondary School*

Mathematics and Science Literacy	Advanced Mathematics	Physics
• Australia	• Australia	• Australia
• Austria	• Austria	• Austria
• Canada	• Canada	• Canada
• Cyprus	• Cyprus	• Cyprus
• Czech Republic	• Czech Republic	• Czech Republic
• Denmark	• Denmark	• Denmark
• France	• France	• France
• Germany	• Germany	• Germany
• Hungary	• Greece	• Greece
• Iceland	• Israel[1]	• Israel[1]
• Israel[1]	• Italy	• Italy[2]
• Italy	• Lithuania	• Latvia
• Lithuania	• Russian Federation	• Norway
• Netherlands	• Slovenia	• Russian Federation
• New Zealand	• Sweden	• Slovenia
• Norway	• Switzerland	• Sweden
• Russian Federation	• United States	• Switzerland
• Slovenia		• United States
• South Africa		
• Sweden		
• Switzerland		
• United States		

* See Appendix A for characteristics of students tested.

[1] Because the characteristics of its sample are not completely known, achievement results for Israel are provided in Appendix D.

[2] Because it had a small sample for the physics testing, Italy's physics achievement results are provided in Appendix D.

What Are the Differences in Upper Secondary Education Systems?

The countries participating in TIMSS vary greatly with respect to their upper secondary education systems. Some countries provide comprehensive education to students in their final years of school, while in other countries students might attend academic, vocational, or technical schools. Some countries fall between these extremes, their students being enrolled in academic, vocational, technical, or general programs of study within the same schools. Across countries the definitions of academic, vocational, and technical programs also vary, as do the kinds 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. 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, determining when schooling in vocational programs is completed is not always straightforward.

The differences across countries in how education systems are organized, how students proceed through the upper secondary system, and when students leave school posed a challenge in defining the target populations to be tested in each country and interpreting the results. In order to make valid comparisons of students' performance across countries, 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 know 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 for interpreting the achievement results presented in this report, Appendix A summarizes the structure of the upper secondary system for each country, and specifies the grades and tracks (programs of study) in which students were tested for TIMSS.[8]

[8] Additional information about the education systems can be found in 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.

The TIMSS Coverage Index: What Percent of the School-Leaving Age Cohort Was Tested?

Historically, an important difference between education systems was the proportion of an age cohort that successfully completed upper secondary education. In the 1960s, for example, completion rates among OECD countries ranged from more than 80% in the United States to between 17% and 33% in southern European countries.[9] One of the most significant developments in education systems around the world in the years since then has been the large increase in the number of students completing upper secondary education, with many countries catching up with the United States; yet there remains considerable variation among countries in completion rates. In order to avoid unwittingly comparing the elite students in one country with the more general population in another, therefore, it is important to be aware of the extent to which the upper secondary system in each country includes the total student population.

So as to learn how much of the school-leaving age cohort was still in school and represented by the TIMSS sample, a TIMSS Coverage Index (TCI) was computed for each country. The TCI is an estimate of the percentage of the school-leaving age cohort covered by the TIMSS final-year student sample. It reflects any omissions from the sample, such as students who were excluded because of handicap or who had dropped out of school, and, in some countries, tracks or educational programs that were not covered by the TIMSS sample. The TCI was computed by forming a ratio of the size of the student population covered by the TIMSS sample, as estimated from the sample itself, to the size of the school-leaving age cohort, which was derived from official population census figures supplied by each country.[10]

Countries with high TCIs have most of their students still in school, and have covered this population with their TIMSS sample. Countries with low TCIs have fewer students still in school, or have excluded some components of their system from their sample (or both). Table 2 presents the TCI for each country, and also shows the two parts of the portion of the school-leaving age cohort not covered by the TIMSS sample: system components and students excluded by the country, and others – primarily young people who chose not to complete upper secondary education. The percentage of the age cohort covered by the TIMSS sample (the TCI), the percentage excluded from the sample, and the percentage of others not covered combine to form 100% of the school-leaving age cohort. For example, Australia has a TCI of 68.1%, which indicates that the TIMSS sample of final-year students covers just over two-thirds of the school-leaving age cohort. Of the remainder, 4% have been excluded from the sample, and the remaining 27.9% are presumably no longer attending school. The TCI for Cyprus is lower (47.9%), partly because Cyprus excluded students in private schools and in vocational programs (13.5%), and partly because a greater percentage of the age cohort is no longer attending school (38.6%).

[9] OECD (1996). *Education at a Glance - Analysis.* Paris: Organization for Economic Co-operation and Development.

[10] For more information on the TIMSS Coverage Index, see Appendix B.

Table 2

TIMSS Coverage Indices (TCIs)

Country	TIMSS Coverage Index (TCI)*	Sample Exclusions[†]	Others Not Covered	Notes on Exclusions
Australia	68.1%	4.0%	27.9%	
Austria	75.9%	16.8%	7.3%	Colleges and courses lasting less than 3 years excluded
Canada	70.3%	6.8%	22.9%	
Cyprus	47.9%	13.5%	38.6%	Private and vocational schools excluded
Czech Republic	77.6%	5.0%	17.4%	
Denmark	57.7%	1.3%	41.0%	
France	83.9%	0.9%	15.3%	
Germany	75.3%	9.6%	-	
[1] Greece	10.0%	56.8%	33.2%	Only students having taken advanced mathematics and physics included
Hungary	65.3%	0.1%	34.6%	
Iceland	54.5%	0.0%	45.4%	
[2] Israel	-	-	-	
Italy	51.5%	0.5%	48.0%	
[1] Latvia	3.0%	16.8%	80.3%	Only students having taken physics included
Lithuania	42.5%	0.0%	57.5%	
Netherlands	78.0%	21.5%	0.5%	Apprenticeship programs excluded
New Zealand	70.5%	0.0%	29.5%	
Norway	84.0%	3.3%	12.7%	
Russian Federation	48.1%	36.3%	15.7%	Vocational schools and non-Russian speaking students excluded
Slovenia	87.8%	5.6%	6.6%	
South Africa	48.9%	0.0%	51.1%	
Sweden	70.6%	0.2%	29.2%	
Switzerland	81.9%	2.1%	16.0%	
United States	63.1%	2.5%	34.5%	

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

* TIMSS Coverage Index (TCI): Estimated percentage of school-leaving age cohort covered by TIMSS sample. See Appendix B for details.

† Percentage different from that reported in Table B.4 because this is based on the entire school-leaving age cohort rather than the population of those students attending school.

1 Results for Greece are reported only for advanced mathematics and physics; results for Latvia are available only for physics.

2 The TCI could not be computed for Israel.

Table 3

TIMSS Coverage Indices (TCIs) for Advanced Mathematics and Physics

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

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

* MTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of advanced mathematics students. See Appendix A for characteristics of students sampled and Appendix B for details about the MTCI.

† PTCI: Estimated percentage of school-leaving age cohort covered by TIMSS sample of physics students. See Appendix A for characteristics of students sampled and Appendix B for details about the PTCI.

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

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

[3] Latvia sampled only students having taken physics.

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

TIMSS also tested two overlapping subpopulations of the final-year student population: students having taken advanced mathematics, and students having taken physics. In most countries, each group consists of a minority of students from the final-year student population. Table 3 presents the percentage of students in the final-year sample having taken advanced mathematics and the percentage having taken physics. Apart from Slovenia, where a large percentage of upper secondary students take advanced mathematics, the percentage having taken advanced mathematics varies from about 4% in the Russian Federation to about 44% in Austria, with a similar range in physics.

In order to quantify the coverage of the advanced mathematics and physics samples and help interpret the achievement results for these students, TIMSS computed a Mathematics TIMSS Coverage Index (MTCI) and a Physics TIMSS Coverage Index (PTCI), as shown in Table 3. The MTCI is the overall TCI multiplied by the percentage of the final-year sample having taken advanced mathematics. For example, in Australia 23.1% of the final-year sample had taken advanced mathematics. Multiplying this by the TCI (68.1%, from Table 2) gives a MTCI of 15.7%, as shown in the second column of Table 3. This implies that about 16% of the school-leaving age cohort in Australia had taken advanced mathematics in upper secondary school. Similarly, the PTCI for Australia is 12.6%, as shown in the fourth column of Table 3.

How Does TIMSS Document Compliance with Sampling Guidelines?

In addition to a clear definition of the populations assessed, valid samples and high participation rates in each country are crucial to the quality and success of any international comparative study. The accuracy of the survey results depends on the quality of sampling information and particularly on the quality of the samples. TIMSS developed procedures and guidelines to ensure that the national samples were of the highest quality possible. Standards for coverage of the target population and participation rates were established, as were clearly documented procedures on how to obtain the national samples. Despite efforts to meet the TIMSS specifications, some countries did not do so. These countries are specially footnoted or shown in separate sections of the tables in this report.[11]

Despite the differences in the structure of the upper secondary systems and the proportion of the school-leaving age cohort assessed, and the difficulties some countries had in meeting the TIMSS sampling requirements, the assessment of final-year students provides valuable comparative information about student achievement. This report describes in as much detail as possible which students were tested in each country, so that the achievement results can be understood and compared appropriately.

[11] The TIMSS sampling requirements and the outcomes of the sampling procedures are described in Appendix B.

How Do Country Characteristics Differ?

International studies of student achievement provide useful information about student performance and instructional practices. The benefits of these studies, however, are accompanied by the problems of comparing achievement across countries, cultures, and languages. In TIMSS, extensive efforts were made to attend to these issues through careful planning and documentation, cooperation among the participating countries, standardized procedures, and rigorous attention to quality control throughout.[12]

Beyond the integrity of the study procedures, the results of comparative studies such as TIMSS also need to be considered in light of the larger contexts in which students are educated and the systemwide factors that might influence students' opportunity to learn. A number of these factors are summarized in Appendix A and more fully described in *National Contexts for Mathematics and Science Education: An Encyclopedia of the Education Systems Participating in TIMSS*.[13] However, differences among the participating countries go beyond how their educational systems are organized. Selected demographic characteristics of the TIMSS countries are presented in Table 4, and Table 5 contains information about public expenditure on education. These tables show that some of the TIMSS countries are densely populated and others are more rural, some are large and some small, and some expend considerably more resources on education than others. Although these factors do not necessarily determine high or low performance in mathematics or the sciences, they do provide a context for considering the difficulty of the educational task from country to country.

Describing students' educational opportunities also requires an understanding of the knowledge and skills that students are supposed to master. To help complete the picture of educational practices in the TIMSS countries, mathematics and curriculum specialists in each country provided detailed categorizations of their curriculum guides, textbooks, and curricular materials. The initial results from this effort can be found in two reports, entitled *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.*[14]

Depending on the education system, students' learning goals are commonly set at one of three levels: the national or regional level, the school level, or the classroom level. Some countries are highly centralized, with the ministry of education (or highest authority in the system) having exclusive responsibility for making the major decisions governing the direction of education. In others, such decisions are made regionally or locally. Each approach has its strengths and weaknesses. Centralized decision-making can add coherence in curriculum coverage, but may constrain a school or teacher's flexibility in tailoring instruction to the needs of students.

[12] Appendix B summarizes the procedures used and cites references to TIMSS methodology.

[13] 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.

[14] 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.

Table 4

Selected Demographic Characteristics of TIMSS Countries

Country	Population Size (1,000)[1]	Area of Country (1000 Square Kilometers)[2]	Density (Population per Square Kilometer)[3]	Percentage of Population Living in Urban Areas	Life Expectancy[4]	Percent in Secondary School[5]
Australia	17843	7713	2.29	84.8	77	84
Austria	8028	84	95.28	55.5	77	107
Canada	29248	9976	2.90	76.7	78	88
Cyprus	726	9	77.62	53.6	77	95
Czech Republic	10333	79	130.99	65.3	73	86
Denmark	5205	43	120.42	85.1	75	114
France	57928	552	104.56	72.8	78	106
Germany	81516	357	227.39	86.3	76	101
Greece	10426	132	78.63	64.7	78	99
Hungary	10261	93	110.03	64.2	70	81
Iceland	266	103	2.56	91.4	79	103
Israel	5383	21	252.14	90.5	77	87
Italy	57120	301	189.36	66.6	78	81
Latvia	2547	65	40.09	72.6	68	87
Lithuania	3721	65	57.21	71.4	69	78
Netherlands	15381	37	409.30	88.9	78	93
New Zealand	3493	271	12.78	85.8	76	104
Norway	4337	324	13.31	73.0	78	116
Russian Federation	148350	17075	8.70	73.2	64	88
Slovenia	1989	20	97.14	62.7	74	85
South Africa	40539	1221	32.46	50.5	64	77
Sweden	8781	450	19.38	83.1	78	99
Switzerland	6994	41	168.03	60.6	78	91
United States	260650	9809	27.56	76.0	77	97

SOURCE: The World Bank, Social Indicators of Development, 1996.

[1] Estimates for 1994 based, in most cases, on a de facto definition. Refugees not permanently settled in the country of asylum are generally considered to be part of their country of origin.

[2] Area is the total surface area in square kilometers, comprising all land area and inland waters.

[3] Density is population per square kilometer of total surface area.

[4] Number of years a newborn infant would live if prevailing patterns of mortality at its birth were to stay the same throughout its life.

[5] Enrollment of students of all ages in the secondary school system as a percentage of the number of persons in the age group that attends secondary school. The age range varies across countries, but is usually 12-17. The percentage may be in excess of 100% if some pupils are younger or older than the country's standard range of secondary school age.

Table 5

Public Expenditure on Education at Primary and Secondary Levels[1] in TIMSS Countries

Country	Gross National Product per Capita (US Dollars)[2]	Gross National Product per Capita (Intl. Dollars)[3]	Public Expenditure on Education (Levels 1&2) as % of Gross National Product[4]	Public Expenditure on Education (Intl. Dollars per Capita)[5]
Australia	17980	19000	3.69	701
Austria	24950	20230	4.24	858
Canada	19570	21230	4.62	981
[6] Cyprus	10380	-	3.60	-
Czech Republic	3210	7910	3.75	297
Denmark	28110	20800	4.80	998
France	23470	19820	3.61	716
Germany	25580	19890	2.43	483
Greece	7710	11400	2.27	259
Hungary	3840	6310	4.31	272
Iceland	24590	18900	4.77	902
Israel	14410	15690	3.72	584
Italy	19270	18610	2.89	538
Latvia	2290	5170	2.85	147
Lithuania	1350	3240	2.18	71
Netherlands	21970	18080	3.30	597
New Zealand	13190	16780	3.15	529
Norway	26480	21120	5.26	1111
Russian Federation	2650	5260	-	-
Slovenia	7140	-	4.20	-
South Africa	3010	-	5.12	-
Sweden	23630	17850	4.92	878
Switzerland	37180	24390	3.72	907
United States	25860	25860	4.02	1040

SOURCE: The World Bank Atlas, 1996; and UNESCO Statistical Yearbook, 1995

[1] The levels of education are based on the International Standard Classification of Education. The duration of Primary (level 1) and Secondary (level 2) vary depending on the country.

[2] Estimates for 1994 at current market prices in U.S. dollars, calculated by the conversion method used for the World Bank Atlas. (Source: The World Bank Atlas, 1996).

[3] Converted at purchasing power parity (PPP). PPP is defined as number of units of a country's currency required to buy the same amounts of goods and services in the domestic market as one dollar would buy in the United States. (Source: The World Bank Atlas, 1996).

[4] Calculated by multiplying the Public Expenditure on Education as a % of GNP by the percentage of public education expenditure on the first and second levels of education. Figures represent the most recent figures released. (Source: UNESCO Statistical Yearbook, 1995).

[5] Calculated by multiplying the GNP per Capita (Intl. Dollars) column by Public Expenditure on Education.

[6] GNP per capita figure for Cyprus is for 1993.

(-) A dash indicates the data were unavailable.

Figures 1, 2, and 3 show the degree of centralization in the TIMSS countries regarding decision-making about curriculum syllabi, textbooks, and examinations. Fourteen of the TIMSS participants reported nationally centralized decision-making about curriculum. Fewer countries reported nationally centralized decision-making about textbooks: six participants were in this category. Eight countries reported nationally centralized decision-making about examinations. Regional decision-making about these three aspects of education does not appear to be very common, with only a few countries reporting it for curriculum syllabi and textbooks, and none reporting it for examinations.

Most countries reported having centralized decision-making for one or two of the areas and "not centralized" decision-making for one or two of the areas. Two countries, Lithuania and Norway, reported nationally centralized decision-making for all three areas: curriculum syllabi, textbooks, and examinations. Five countries – Australia, Hungary, Iceland, Latvia, and the United States – reported that decision-making is not centralized for any of these areas.

Figure 1

Centralization of Decision-Making Regarding Curriculum Syllabi

Criteria

Countries are in the "Nationally Centralized" category regarding curriculum if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for or gives final approval of the syllabi for courses of study. If curriculum syllabi are determined at the regional level (e.g., state, province, territory), a country is in the "Regionally Centralized" category. If syllabi for courses of study are not determined nationally or regionally, a country is in the "Not Centralized" category.

Nationally Centralized

Austria
Cyprus
Czech Republic
Denmark
France
Greece
Israel
Italy
Lithuania
New Zealand
Norway[1]
Slovenia
South Africa
Sweden[2]

Regionally Centralized

Canada
Germany
Switzerland[3]

Not Centralized

Australia[4]
Hungary[5]
Iceland
Latvia
Netherlands[6]
Russian Federation
United States

1 Norway: The National Agency of Education provides goals which schools are required to work towards. Schools have the freedom to implement the goals based on local concerns.

2 Sweden: The National Agency of Education provides goals which schools are required to work towards. Schools have the freedom to implement the goals based on local concerns.

3 Switzerland: Decision-making regarding curricula in upper secondary varies across the cantons and the types of education.

4 Australia: Students tested in TIMSS were educated under a decentralized system. Reforms beginning in 1994 are introducing regionally centralized (state-determined) curriculum guidelines.

5 Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

6 Netherlands: The Ministry of Education sets core objectives (for subjects in primary education and in 'basic education' at lower secondary level) and goals/objectives (for subjects in the four student ability tracks in secondary education) which schools are required to work towards. Schools have the freedom, though, to decide how to reach these objectives.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995. Information provided by TIMSS National Research Coordinators.

Figure 2

Centralization of Decision-Making Regarding Textbooks

Criteria

Countries are in the "Nationally Centralized" category regarding textbooks if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for determining the approved textbooks. If textbooks are selected from a regionally approved list (e.g., state, province, territory), a country is in the "Regionally Centralized" category. If that decision-making body has less than exclusive responsibility for determining the approved textbooks, a country is in the "Not Centralized" category.

Nationally Centralized	Regionally Centralized	Not Centralized
Austria	Canada	Australia
Cyprus	Germany	Czech Republic
Greece	South Africa	Denmark
Lithuania	Switzerland[1]	France
Norway		Hungary[2]
Slovenia		Iceland
		Israel
		Italy
		Latvia
		Netherlands
		New Zealand
		Russian Federation
		Sweden
		United States

[1] Switzerland: Decision-making regarding textbooks in upper secondary varies across the cantons and the types of education.

[2] Hungary: Hungary is in the midst of changing from a highly centralized system to one in which local authorities and schools have more autonomy.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96. Information provided by TIMSS National Research Coordinators.

Figure 3

Centralization of Decision-Making Regarding Examinations

Criteria

Countries are in the "Nationally Centralized" category regarding examinations if the highest level of decision-making authority within the educational system (e.g., the ministry of education) has exclusive responsibility for or gives final approval of the content of examinations. The notes explain during which school years the examinations are administered. If that decision-making body has less than exclusive responsibility for or final approval of the examination content, the country is in the "Not Centralized" category.

Nationally Centralized	Not Centralized
Denmark[1]	Australia[7]
Italy[2]	Austria
Lithuania	Canada
Netherlands[3]	Cyprus
New Zealand[4]	Czech Republic
Norway[5]	France
Russian Federation[6]	Germany[8]
South Africa	Greece
	Hungary
	Iceland
	Israel[9]
	Latvia[10]
	Slovenia[11]
	Sweden[12]
	Switzerland
	United States

1 Denmark: Written examinations are set and marked centrally. The Ministry of Education sets the rules and framework for oral examinations. However, oral examinations are conducted by the pupil's own teacher, together with a teacher from another school as an external (ministry-appointed) examiner.

2 Italy: At the end of senior secondary courses lasting four or more years, students who have positive evaluations write the final examination, the esame di maturità. Written papers are determined by the Ministry of Education.

3 Netherlands: School-leaving examinations consisting of a centralized part and a school-bound part are taken in the final grades of the four student ability tracks in secondary education.

4 New Zealand: Centralized examinations taken at Years 11, 12, and 13. Centralized national monitoring at Years 4 and 8.

5 Norway: Written examinations are set and marked centrally. The Ministry of Education sets the rules and framework for oral examinations. However, oral examinations are conducted by the pupil's own teacher, together with a teacher from another local school or an external (ministry-appointed) examiner.

6 Russian Federation: Centralized examinations are taken in Grades 9 and 11 in mathematics and Russian/literature.

7 Australia: Not centralized as a country, but low-stakes statewide population assessments are undertaken in most states at one or more of Grades 3, 5, 7, and 10. In most states, centralized examinations are taken at Grade 12.

8 Germany: Not centralized as a country, but is centralized within 6 (of 16) federal states.

9 Israel: Centralized examinations are taken at the end of secondary school that affect opportunities for further education.

10 Latvia: Centralized examinations can be taken at Grade 9 and Grade 12.

11 Slovenia: Two-subject national examinations are taken after Grade 8 (end of compulsory education); five-subject externally-assessed baccalaureat after Grade 12 for everyone entering university.

12 Sweden: There are no examinations in Sweden.

SOURCE: IEA Third International Mathematics and Science Study (TIMSS), 1995-96. Information provided by TIMSS National Research Coordinators.