Chapter 7

The Physics Curriculum in the Participating Countries

The physics assessment for TIMSS Advanced 2008 was developed according to a framework designed to reflect the physics studied around the world in science programs during the final year of schooling. More specifically, the TIMSS Advanced 2008 physics framework[1] was organized around content domains and cognitive domains. The content domains or subject matter to be assessed included mechanics, electricity and magnetism, heat and temperature, and atomic and nuclear physics, while the cognitive domains or thinking behaviors expected of students as they engaged with the physics content included knowing, applying, and reasoning. The TIMSS Advanced 2008 countries participated in the iterative review process used to develop the framework and worked collaboratively with the TIMSS & PIRLS International Study Center to develop the test questions (items) covering the framework. Although all countries agreed that the physics described in the framework and addressed by the items in the assessment represented a reasonable fit to their curricular goals, it must be emphasized that each of the participating countries had its own approach to teaching and learning physics. To better understand the results, therefore, it is important first to understand the differences in the education systems in the

1 Garden, R.A., Lie, S., Robitaille, D.F., Angell, C., Martin, M.O., Mullis, I.V.S., Foy, P., and Arora, A. (2006). *TIMSS Advanced 2008 assessment frameworks*. Chestnut Hill, MA: TIMSS & PIRLS International Study Center, Boston College.

participating countries and the characteristics of the students assessed for TIMSS Advanced.

Because the participating countries took substantively different approaches to educating students in physics, the first section of Chapter 7 contains information about the structure of the educational systems in the countries that participated in TIMSS Advanced 2008, with a particular focus on the number of years of schooling involved and the selectivity of the program or track assessed by TIMSS Advanced. Data are presented about the characteristics of the physics curriculum in each country, and about the students who participated. Later sections deal with the amount of instructional time allocated to physics in these advanced programs or tracks, the degree to which certain topics from the TIMSS Advanced physics framework were taught, and the extent to which teachers indicated that they felt well-qualified to teach physics.

In comparing achievement across countries, it is important to consider differences in students' curricular experiences, how these differences may affect the physics they have studied, and their subsequent achievement. Students' opportunities to learn the physics covered by the TIMSS Advanced 2008 content and cognitive domains depend initially to some degree on that physics being part of each country's guidelines and policies for science education. Thus, participants provided information about various educational policies and the curriculum topics covered in their respective curriculum guidelines (intended curriculum). Inclusion in the country's curriculum, however, does not guarantee students' opportunity to learn. Just as important is what their teachers choose to teach them. The content of the lessons provided by the teachers ultimately determines the physics that students are taught (implemented curriculum).

The goal of Chapter 7 is to provide information about the teaching and learning of physics in each of the nine countries that participated in the TIMSS Advanced assessment of physics in 2008. It is hoped that this information will enable readers to compare and contrast the different approaches taken by different countries in this area, in order to establish a basis for making cross-country comparisons of outcome data in subsequent chapters.

Among the topics to be covered in Chapter 7 are an overview of the educational systems in the participating countries, descriptions of the populations of students tested, the characteristics of the physics curriculum, the amount of time devoted to physics in the curriculum at this level, and students' opportunity to learn the topics covered in the TIMSS Advanced physics assessment, including teachers' reports about whether those topics were taught and their feelings about how well prepared they were to teach physics at this level.

Overview of the Educational Systems

Science curricula and instructional practices vary considerably around the world. For example, at the elementary and junior secondary school levels, many countries take a general science approach where various branches of science are integrated into a single course. In other countries, science curricula are organized into separate courses focusing on the major science disciplines: chemistry, biology, physics, earth science, etc. At the secondary school level, and especially in the final year or two of secondary school, significant differences can be found across countries in the topics that are included in their science curricula, in the rates of participation of students in the science courses available at that level, and in the proportions of students still in school and studying physics.

Such considerations add to the complexity of making achievement comparisons across countries at this level, but they also heighten the degree of interest in those comparisons. When all children are in school learning the basic concepts of science, cross-country comparisons, while complicated by socioeconomic and cultural factors among others, are somewhat less problematic. But when there are substantial variations among countries with respect to these kinds of factors, as there are at the senior secondary level, straightforward comparisons are more difficult to draw. Thus, readers of this report are cautioned to be judicious in drawing conclusions about the relative strengths of national systems of education on the basis of the results presented in this volume. The results can be used to examine the range of educational outcomes produced in different countries, and to illustrate the wide range of educational choices that are in effect in those countries.

Exhibit 7.1 presents information about how the overall curriculum for upper secondary school and the physics program are structured in each of the nine countries that participated in TIMSS Advanced 2008. In eight of the nine countries, the last year of secondary school is either the 11th or the 12th year of schooling. The exception is Italy, where the last year of secondary school in some programs is the 13th year. Normally, students in the Russian Federation would complete secondary school after 11 years of schooling; however, about half of the students in their final year at the time of the TIMSS Advanced data collection were in their 10th year, having skipped Year 4 as part of the implementation process for the current program.

In five of these nine countries—Armenia, Iran, Lebanon, the Netherlands, and Sweden—upper secondary schooling consists of a 3-year program. However, in Norway and the Russian Federation, it is 2 years, in Slovenia it is 4 years, and in Italy it can be 5 years. The

Netherlands may also be considered to have a 5-year program since it includes 2 years of basic education where students follow the same curriculum. The number of hours of physics studied per year was in the range of 100 to 140 hours for most countries, with Slovenia and Sweden reporting a somewhat lower time allocation of 75 to 79 hours and Lebanon reporting a somewhat higher time allocation of 166 hours per year.

In some of the countries, including Armenia, Iran, Italy, and the Russian Federation, students had to meet entrance requirements (e.g., previous grades, exams, recommendations) to be permitted to enroll in the physics program. In the rest of the countries, students appeared to have considerable latitude in making decisions about which program to follow after completing basic education or general courses required of all students.

In several countries, the students who were identified for participation in TIMSS Advanced 2008 were enrolled in rather highly specialized programs, notably Armenia where the TIMSS physics students were enrolled in the "physmat" program and, similarly in Iran, where the track assessed was specifically for university bound students studying both mathematics and physics. In the Netherlands, most of the TIMSS physics students were taking a specialized physics program as part of the science and technology program, and in the Russian Federation they studied physics for 3 hours or more per week in any of several types of schools. In other countries, a somewhat broader cross-section of the final year population was represented.

Exhibit 7.1 **Structural Characteristics of the Physics Programs (Tracks) Assessed by TIMSS Advanced 2008**

TIMSSAdvanced2008 Physics

Country	Description of How the Programs (Tracks) Fit into Overall Curriculum	Number of Years Students Spent in These Programs (Tracks)	Number of Hours of Physics Instruction in Total	Criteria for Admission to These Programs (Tracks)
Armenia	Secondary schooling is a 3-year program up to the 11th grade. All students follow the same curriculum through the 3-year program, although students in a small number of special "physmat" schools cover additional topics in mathematics and science. Students at the 11th grade in these "physmat" schools constitute the target population for TIMSS Advanced 2008. As a result of recent reforms to increase the number of years of school, Armenian students were assessed in what is now called the 11th grade. However, since the assessed students skipped a grade as part of implementing the reform, they have had 10 years of formal schooling.	Three years	108	Completion of elementary school and success on the centralized state examination after the 9th grade.
Iran, Islamic Rep. of	After lower secondary school (grade 9), students can choose the track they wish to attend in upper secondary school. Students who complete the 11th grade in the mathematics track are allowed to participate in the advanced mathematics and physics track in the pre-university stage. This advanced mathematics and physics track is the target population assessed by TIMSS Advanced 2008.	Three years	110	For enrollment in the advanced mathematics and physics track, students' cumulative grade point average at the 9th grade, their grades in mathematics and science, and the opinion of the school counselor are taken into consideration.
Italy	Secondary education can last 3, 4, or 5 years and is given in four types of schools: classical schools, scientific schools, technical schools, and vocational schools. The students assessed by TIMSS Advanced 2008 are in grade 13 and have taken an advanced mathematics and physics course. Most of these students are found in the Liceo Scientifico (general schools with scientific focus), Liceo Scientifico Tecnologico (general school with a focus on technology), or Instituti Technici (vocational full time training).	Five years	100	Completion of lower secondary education and success on the national examination after the 8th grade.
Lebanon	Secondary schooling is a 3-year program up to the 12th grade. All students follow the same curriculum in their first year. In the second year, students can choose between humanities and sciences and in the third year, students from the sciences can choose from one of three programs: sociology and economics, life science, or general science. Students from the general science program at the 12th grade constitute the TIMSS Advanced 2008 target population.	Three years	166	Diploma from basic education (brevet).
Netherlands	Secondary education begins with 2 years (grades 7 and 8) of basic education where all students follow the same curriculum. Students can then choose one of three tracks. In the pre-university track (VWO) which is a 4-year program, in the first year (grade 9) all students follow the same curriculum. The next year (grade 10) they can choose one of four programs. Students who select the Physics 2 course—most of whom come from the science and technology program—constitute the target population for TIMSS Advanced 2008.	Three years	112*	Students are free to enroll in the different tracks based on their ability and interest.
Norway	The Norwegian students assessed for TIMSS Advanced 2008 had 9 years of compulsory education followed by 3 years of secondary education. The first year of secondary education consists of general courses for all students in the academic track. In the last 2 years, students choose which subjects they want to take. Physics courses in the last 2 years consists of 2FY and 3FY. The students assessed by TIMSS Advanced 2008 were in the final year of secondary education and had taken the 3FY physics course. After implementing a curriculum reform, the Norwegian school system consists of 13 years of schooling.	Two years	140	Completion of all general courses in the first year of upper secondary schooling.

Data provided by National Research Coordinators.

* Instructional time is not prescribed for physics. According to the curriculum, a total of 560 hours over three years should be spent by the students on physics (including homework and instruction). About 60% on average should be spent as class time.

Exhibit 7.1 **Structural Characteristics of the Physics Programs (Tracks) Assessed by TIMSS Advanced 2008 (Continued)**

TIMSSAdvanced2008 Physics

Country	Description of How the Programs (Tracks) Fit into Overall Curriculum	Number of Years Students Spent in These Programs (Tracks)	Number of Hours of Physics Instruction in Total	Criteria for Admission to These Programs (Tracks)
Russian Federation	All students study mathematics and physics every year in basic and upper secondary education. In basic education, all students follow the same curriculum, but in upper secondary (grades 10 and 11), the programs differ. The students assessed by TIMSS Advanced 2008 are the 11th grade students who had 3 hours or more per week of instruction in physics. These students can be found in lyceums, gymnasiums, special schools for mathematics and physics, and general secondary schools with different profiles in the upper secondary level. As a result of an ongoing reform to increase the number of years of school, Russian students were assessed in what is now called the 11th grade and about half the students have had 11 years of formal schooling. However, the other half skipped grade 4 as part of implementing the reform and only have had 10 years of formal schooling.	Two years	102	Admission to the physics course involves a written test, interview and students' performance in physics for the previous years of schooling.
Slovenia	The Slovenian students assessed for TIMSS Advanced 2008 had 8 years of elementary education and 4 years of secondary education. Secondary education in Slovenia consists of two types of programs: general gymnasia and vocational or technically oriented programs. Only the general gymnasia program offers students the possibility of admission to university studies. Students in the fourth year of general gymnasia programs who chose to take an additional physics course in their final year were the target population assessed in physics by TIMSS Advanced 2008. Currently, Slovenia is in the process of increasing elementary school to 9 years, so that students will have 13 years of schooling.	Four years	79	Completion of elementary schooling. There are no other special admission criteria for the general gymnasia program.
Sweden	Upper secondary education starts from grade 10 and is divided into 17 national 3-year programs. Of these programs, the natural science program has two mandatory physics courses (Physics A and B) while the technology program has one mandatory physics course (Physics A) and one optional course (Physics B). The students assessed by TIMSS Advanced 2008 were the 12th grade students who had taken the Physics B course.	Three years	75	Completion of compulsory education. Students are then free to choose any upper secondary program.

Data provided by National Research Coordinators.

Description of the Students Assessed for TIMSS Advanced 2008

More information about the makeup of the TIMSS Advanced 2008 target populations in the participating countries can be found in Exhibit 7.2. As noted in the first column of data, the number of students in the program or track assessed for TIMSS Advanced 2008 varied from about 1600 students in Slovenia to over 100,000 in the Islamic Republic of Iran. Students in their final year of schooling were older in some countries than they were in others, ranging from a low of 17 years in the Russian Federation, to highs of 19 in Italy, Norway, Slovenia, and Sweden (with 12 or 13 years of schooling).

Because the number of students taking physics in a country is affected not only by the size of the country but also by the selectivity of the program or track, Exhibit 7.2 provides information about the relative situation in each of the nine countries. In particular, the TIMSS Advanced Physics Coverage Index shown in the fourth data column of Exhibit 7.2 provides a means of comparing the relative sizes of the populations included in the study in these countries. The coverage index for a given country is an estimate of the percentage of the entire national age cohort covered by the TIMSS Advanced target population. It may be helpful to consider the TIMSS Advanced Coverage Index as a fraction, expressed as a percentage. For most countries, the denominator of the fraction (found in the third data column) is the estimate of the size of the entire national population for the same age cohort as the students tested for TIMSS Advanced. For example, the students assessed in Iran for TIMSS Advanced were, on average, 18 years old (the second data column), so the population estimate for Iran in the third data column is for all 18-year olds in Iran. For Armenia, Lebanon, and Slovenia, data for the age cohorts were not available year-by-year but only for the group of students aged 15 to 19

Exhibit 7.2 **Size of the TIMSS Advanced 2008 Target Population for Physics, the Age Cohort, and the TIMSS Advanced Physics Coverage Index**

TIMSSAdvanced 2008 Physics

Country	Estimated Size of the Population of Students in the Final Year of Secondary School Taking the Physics Track or Program Targeted by TIMSS Advanced (Derived from TIMSS Advanced Student Sample)	Age Cohort Corresponding to the Final Year of Secondary School	Size of the Age Cohort Corresponding to the TIMSS Advanced Population Based on National Census Figures[a]	TIMSS Advanced Physics Coverage Index – the Ratio of the Estimated Size of the TIMSS Advanced Target Student Population (Column 2) to the Size of the Corresponding Age Cohort (Column 4)	Years of Formal Schooling*
Armenia	2,684	18	62,758	4.3%	10
Iran, Islamic Rep. of	111,908	18	1,705,000	6.6%	12
Italy	23,176	19	605,507	3.8%	13
Lebanon	4,724	18	79,784	5.9%	12
Netherlands	6,889	18	205,200	3.4%	12
Norway	4,181	19	61,093	6.8%	12
Russian Federation	52,934	17	2,073,041	2.6%	10/11
Slovenia	1,635	19	21,815	7.5%	12
Sweden	13,873	19	125,923	11.0%	12

a Armenia: Estimate derived by dividing the population of 15–19-year olds by 5 for the single year estimate for the year 2008. Data taken from the U.S. Census Bureau's International Database (www.census.gov/). Islamic Rep. of Iran: Total population of 18-year olds in Iran in 2008. Data taken from the Statistical Center of Iran (SCI) (http://www.sci.org.ir/portal/faces/public/sci_en). Italy: Total population of 19-year olds in Italy for the year 2008. Data taken from the Italian Bureau of Statistics (ISTAT) (http://demo.istat.it/pop2008/index.html). Lebanon: Estimate derived by dividing the population of 18–20-year olds by 3 for the single year estimate. Data taken from the Central Bureau for Statistics in the Ministry of Interior. Netherlands: Estimate based on data taken from the Central Bureau of Statistics in the Netherlands (www.cbs.nl). Norway: Total population of 19-year olds in Norway on 1 January 2008. Data taken from the Norwegian National Bureau of Statistics (SSB) (http://www.ssb.no/english/). Philippines: Population of 16-year olds for 2008 projected from the 2000 census. Data taken from the National Statistics Office, Philippines (NSO) (http://www.census.gov.ph/). Russian Federation: Total population of 17-year olds in 2008. Data taken from the Federal State Statistics Service (http://www.gks.ru/wps/portal/english). Slovenia: Estimate was derived by dividing the population of 15–19-year olds by 5 for the single year estimate for the year 2008. Data taken from the Statistical Office of the Republic of Slovenia (www.stat.si). Sweden: Total population of 19-year olds in Sweden for the year 2008. Data taken from Statistics Sweden (SCB) (http://www.scb.se/default____2154.aspx). Data provided by National Research Coordinators.

* Represents years of formal schooling counting from the first year of primary or basic education (first year of ISCED Level1). Because of ongoing reforms in some countries to increase the number of years of schooling, the number of years of formal schooling is not always the same as the grade assessed (see Exhibit 7.1).

(18 to 20 for Lebanon), so the population estimates for those countries are averages. The numerator of the fraction is the estimated size of the target population assessed by TIMSS Advanced derived from the TIMSS Advanced student sample (first data column).

The TIMSS Advanced Physics Coverage Index expresses the number of students enrolled in the physics program or track assessed by TIMSS Advanced as a percentage of all of the students of the same age who could potentially have been in the advanced program or track (if they had all continued their schooling to the final year, wanted to be in the program, and had all been accepted). That is, this is the percentage of students in the age cohort in each country receiving the most elite physics education. The exhibit shows that the range of the coverage index for physics is considerably smaller than was the case for advanced mathematics. The lowest coverage index for physics was 2.6 percent in the Russian Federation, and the highest was 11 percent in Sweden.

The countries that participated in TIMSS Advanced 2008 were very different both in terms of the overall size of their age cohorts (which depend on the size of their national populations), and the numbers of students enrolled in their physics programs (which depend both on the size of the population and the degree of selectivity and availability of the program or track assessed). In Iran and the Russian Federation, the estimated size of the age group from which the TIMSS Advanced 2008 population was selected was greater than 1.5 million. At the opposite extreme, the size of the comparable age cohort in Slovenia was less than 25,000. Armenia, Lebanon, and Norway also had rather small age cohorts, with each being between 60 and 80 thousand.

Characteristics of the Physics Curriculum

Exhibit 7.3 summarizes how recently the physics curriculum has been updated in each of the participating countries. It shows that, in all countries, the physics curriculum either had been revised within the 10 years preceding the TIMSS Advanced 2008 assessment, or was in the process of revision.

Exhibit 7.4 contains summary information for each country about whether the TIMSS Advanced 2008 physics topics were covered in their national curriculum guidelines. The information about topics included in the participants' curricula is discussed in greater depth in Exhibits 7.12 through 7.16, which also include information about the implemented curriculum and provide the results topic-by-topic within each content domain. In general, the countries reported a high degree of correspondence between the topics covered by the TIMSS Advanced 2008 physics assessment and the topics included in their national curricula for the programs, tracks, or courses identified to be assessed in TIMSS Advanced. As previously described, the framework and the test items for the TIMSS Advanced 2008 physics assessment covered four content domains: mechanics, electricity and magnetism, heat and temperature, and atomic and nuclear physics. As is shown in Exhibit 7.4, the test items dealt with 17 physics topics chosen from the four content domains: 7 in mechanics, 4 in electricity and magnetism, 3 in heat and temperature, and 3 in atomic and nuclear physics.

The vast majority of topics included in the TIMSS Advanced 2008 physics framework were included in the physics curricula of all the participating countries. In all countries, almost all (15 or more out of 17) of the topics from the TIMSS Advanced 2008 physics framework were included in their intended curriculum. All four content domains had very high inclusion rates in all countries.

Exhibit 7.3 **Structural Characteristics of the Physics Curriculum in Participating Countries**

TIMSSAdvanced 2008 Physics

Country	Year Curriculum Taken by Students Assessed in TIMSS Advanced Was Introduced	Curriculum Changes
Armenia	2006	
Iran, Islamic Rep. of	1998	
Italy	1923; last revised: Technical Schools 1994, Lyceum 2000	The curriculum is being revised to increase the number of hours of teaching the English language, mathematics and science. The new curriculum will be introduced in 2010.
Lebanon	2001	
Netherlands	1998	Various areas of physics content have been combined and the number of instructional hours have been reduced. Consequently, there are fewer topics in the curriculum and on the final examination. The new curriculum started in August 2007 in grade 10 and therefore has not affected the students participating in TIMSS Advanced 2008.
Norway	1998	A new curriculum was implemented in 2006 with more emphasis on competencies and basic skills, and less on instructional methods. The TIMSS Advanced population belonged to the last cohort not affected by this curriculum reform.
Russian Federation	2004	
Slovenia	1998	In 1998, the curriculum for the general gymnasia program was changed to align with the compulsory Matura examination in terms of contents, standards, number of hours per subject, and content of compulsory parts of optional courses. The previous curriculum for all 4 years of secondary schools was divided into one curriculum for the general gymnasia program and a curriculum for vocational or technically oriented programs with the former being more advanced in all subjects.
Sweden	2000	The curriculum is under revision and is intended to be implemented in 2011.

Data provided by National Research Coordinators.

Exhibit 7.4 **Number of TIMSS Physics Topics in the Intended Curriculum**

TIMSSAdvanced 2008 Physics

Country	Overall (17 topics)	Mechanics (7 Topics)	Electricity and Magnetism (4 topics)	Heat and Temperature (3 Topics)	Atomic and Nuclear Physics (3 Topics)
Armenia	17	7	4	3	3
Iran, Islamic Rep. of	15	5	4	3	3
Italy	17	7	4	3	3
Lebanon	15	7	4	1	3
Netherlands	15	6	3	3	3
Norway	17	7	4	3	3
Russian Federation	17	7	4	3	3
Slovenia	16	6	4	3	3
Sweden	16	6	4	3	3

Data provided by National Research Coordinators.

Because the TIMSS Advanced assessment attempted to align with instructional practices as much as possible, the assessment was designed so that students could use calculators in ways that mirrored their classroom experiences without unduly advantaging or disadvantaging students either way. Exhibit 7.5 summarizes information concerning the policies in effect in the countries with respect to the use of calculators and computers in physics classrooms and during examinations. All participating countries reported permitting students to use calculators of various kinds on national examinations. Two countries, Iran and the Russian Federation, indicated that there was little, if any, mention of calculator and computer use in official documents related to the curriculum. In some countries, curriculum documents encourage teachers to explore applications of technology with their students, but do not provide a lot of specific suggestions or recommendations. Some countries allow students to use graphing calculators during examinations; others forbid their use. In the Netherlands, the examination board each year produces a list of the specific brands of calculators that may be used by students during examinations. On the whole, it seems that mathematics and science educators in many countries are still unsure about how best to incorporate technology into mathematics and science teaching, given the constraints they face in terms of the content of the curriculum and the availability of software of sufficiently high quality and low enough cost to make its adoption possible.

Because public examinations are used in some countries to make decisions about the students enrolled in physics programs, tracks, or courses, participating countries were asked to provide information about their examination systems. Exhibit 7.6 indicates that some type of “high-stakes” examinations (i.e., an examination or system of examinations with academic consequences) were a feature of nearly

Exhibit 7.5 **Curriculum Studied by TIMSS Advanced Students Includes Policies Regarding Use of Computers and Calculators**

TIMSSAdvanced 2008 Physics

Country	Computers	Calculators	Types of Calculators	Calculators in National Examinations	Description of Policies
Armenia	○	○	○	●	Simple calculators are allowed in national examinations.
Iran, Islamic Rep. of	○	○	○	●	Since calculators and computers are not accessible for all students, use of them is not discussed in the national curriculum. Simple calculators only for calculation are permitted in national examination.
Italy	●	○	○	●	There are no policies about the use of calculators. Students use their own calculator during the examinations, but they are not provided. Students use computers while studying some subjects in the lyceum or in specific subjects of technical schools.
Lebanon	○	●	●	●	Non-programmable calculators are permitted. There are no curricular policies about the use of computers. Computer use is optional.
Netherlands	●	●	○	●	Only graphing calculators are allowed in national examinations. The examination board yearly prescribes which brands are allowed.
Norway	●	●	●	●	Graphing calculators are allowed during examinations and frequently used in class. The curriculum, however, only has a vague and general statement about using technological tools in investigations, modeling, and problem solving.
Russian Federation	●	○	○	●	There are no statements about calculator use in the physics curriculum but students are allowed to use nonprogrammable calculators in national examinations. The regional authorities provide free calculators at the examination centers or allow students to bring their own calculators. Concerning computer requirements in the physics curriculum, students should be able to use ICT for searching, processing and presenting the physics information in the computer and web database as the result of studying physics at the advanced level.
Slovenia	●	●	●	●	The national curriculum requires that calculators used in the national examination should be scientific calculators without the capability of symbolic or graphic calculations. During lessons students are allowed to use their own calculators. The use of computers is recommended.
Sweden	●	○	○	●	There are no national examinations in Physics. There is a national test bank, with tasks and tests, and any calculator is allowed to be used on the tests found in the test bank. There are statements in the curriculum that students should develop their ability to use modern technical tools for the collection and analysis of data and for simulation of physics phenomena. This implies use of computers.

● Yes
○ No

every one of these nine educational systems, with the exception of Sweden. In the other participating countries, students write national examinations in physics and other subjects during their final year of secondary school and, in some cases, at other grade levels as well. In most cases the important examinations at the end of secondary school are administered by the Ministry of Education or a national examination board. In Sweden, on the other hand, evaluation is the responsibility of the teacher. There are national examinations, but they are intended to supplement the evaluation information that teachers develop on their own.

The National Research Coordinators responsible for implementing TIMSS Advanced in each of the participating countries were asked to indicate which of six possible methods for evaluating the degree of implementation of the physics curriculum were used in their countries, and their responses are summarized in Exhibit 7.7. The results show that countries tend to use several sources to collect data about curriculum implementation, including results from international comparative studies such as TIMSS Advanced 2008. The most commonly used sources were national examinations, assessments, or tests, while the least frequently used methods were research and evaluation programs and school self-evaluation.

All of the participating countries publish either an official curriculum document or a set of notes and directives detailing the physics curriculum for teachers, as shown in Exhibit 7.8. Most of them also reported either recommending or mandating particular textbooks to be used by teachers and students for the advanced course. Other kinds of support materials were made available for teachers in some, but not all, countries. These materials included some form of a teacher's guide with suggestions for teaching various topics, suggested instructional activities, and a description of the structure and content

Exhibit 7.6 **Examination System in Participating Countries**

TIMSSAdvanced 2008 Physics

Country	Examinations with Consequences for Individuals	Grades at Which Examinations Are Given	Nature and Format of Examination	Purpose of Examination and Consequences	Comments
Armenia	●	Compulsory examinations at grades 9 and 11.		The 9th grade examination is used to determine which students can continue their secondary schooling. The 11th grade examination is necessary for graduation and entry to university.	Both of these are centralized state examinations.
Iran, Islamic Rep. of	●	Examination is given at the pre-university year.	Assessment at pre-university includes mid-semester and final examination.	Passing all subjects in both semesters is a requirement for entering university.	National examinations for grade promotion are given each semester, in two subjects chosen randomly. Examinations in the rest of the subjects are given by the schools. Another national examination is given for entry to the university.
Italy	●	Compulsory examination at the end of grade 8 and at the end of grade 13.	The assessment at grade 13 includes two written tests developed by the Ministry of Education and a third developed by the teacher.	The national examination at grade 8 determines entry to secondary school. The national examination at grade 13 determines entry to university.	Final examination for technical and professional schools also gives students an opportunity to find a job.
Lebanon	●	Examination at the end of the 12th grade.	Written examination.	The examination is used to determine which students have completed secondary schooling and is also used for university admission.	Some university faculties, especially science, engineering and medicine, administer entrance examinations in subjects such as mathematics and physics.
Netherlands	●	There is a national examination at the end of lower-secondary (grade 8) and at the end of upper-secondary education. Depending on the track in upper-secondary the examinations are in grade 10 (pre-vocational), grade 11 (senior general), grade 12 (pre-university).	Diploma for the upper secondary level is given based on three school-based examinations, number of practical assignments, and final national examinations in different subjects.	The pre-university diploma is needed in order to enter into university.	The national examinations are conducted by the National Examination Board.
Norway	●	Students may be selected for examination in the last 2 years of upper secondary school.	Written national examination or oral local examination.	The examination results influence entrance to tertiary education.	National examinations are administered by the Ministry of Education.
Russian Federation	●	There is a national examination in physics at grade 9 and 11 for those who select physics as a basis for graduating and entering the next level.	The grade 9 examination in physics consists of a written as well as an experimental part. The grade 11 examination is conducted in written form.	The 9th grade examination is used to determine which students can continue their secondary schooling. The 11th grade examination is necessary for graduation and entry to university.	The Federal Service of Supervision in Education and Science administers the examination in physics.

● Yes
○ No

Data provided by National Research Coordinators.

Exhibit 7.6 **Examination System in Participating Countries (Continued)**

TIMSSAdvanced 2008 Physics

Country	Examinations with Consequences for Individuals	Grades at Which Examinations Are Given	Nature and Format of Examination	Purpose of Examination and Consequences	Comments
Slovenia	●	There is a national examination at the end of elementary school (grade 8) and at the end of secondary school (grade 12). The national examination at the end of secondary school is called the Matura (General Matura for gymnasia program and Vocational Matura for vocational/ technical programs).	The Matura consists of written and oral examinations from the compulsory subjects of mathematics, mother tongue and foreign language and two subjects of the student's choice. Physics is one of the choices.	Matura is a school-leaving examination required for the completion of secondary education and for university entrance.	A pass in the Matura is a general admission requirement for any academic university study program and a minimal admission requirement for those academic courses having no limit on the number of students. Achievement in the Matura and achievement in the last 2 years of schooling are used to select students where there is a limit to the number of candidates for an university program. The Matura is prepared and administered by the National Examination Center.
Sweden	○				Sweden does not have an examination system with direct consequences for individual students. However, national assessment materials are used as an important tool to support teachers in grading their students.

● Yes
○ No

Data provided by National Research Coordinators.

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Exhibit 7.7 Methods Used to Evaluate the Implementation of the Curriculum for Physics

TIMSSAdvanced 2008 Physics

Country	Visits by Inspectors	Evaluation or Research Programs	School Self-Evaluation	National Examinations, Assessments, or Tests	TIMSS Advanced	Others
Armenia	●	●	●	●	●	● Subject monitored by National Institute of Education
Iran, Islamic Rep. of	●	●	○	●	●	○
Italy	●	○	●	●	●	○
Lebanon	●	●	○	●	●	○
Netherlands	●	○	○	●	○	● Subject monitored and textbooks reviewed by the Netherlands Institute for Curriculum Development (SLO)
Norway	○	●	○	●	●	○
Russian Federation	●	●	●	●	●	● Regional monitoring of students' achievement
Slovenia	○	○	●	●	●	○
Sweden	●	○	●	○	●	○

● Yes ○ No

Data provided by National Research Coordinators.

Exhibit 7.8 Formats in Which the Curriculum for Physics Is Made Available

TIMSSAdvanced 2008 Physics

Country	Official Publication Containing the Curriculum	Ministry Notes and Directives	Mandated or Recommended Textbooks	Instructional or Pedagogical Guide	Specifically Developed or Recommended Instructional Activities	Description of Content of Public Examination	Other
Armenia	●	●	●	●	●	●	○
Iran, Islamic Rep. of	○	●	●	○	○	●	○
Italy	●	●	○	○	●	○	● Professional development for teachers
Lebanon	●	●	●	●	●	●	○
Netherlands	●	●	○	●	●	●	○
Norway	●	●	○	○	○	●	○
Russian Federation	●	●	●	●	●	●	● Professional development for teachers
Slovenia	●	●	●	○	●	●	● Most information (curriculum, etc.) can be found on websites of the Ministry of Education
Sweden	●	○	○	○	○	○	○

of the formal examination to be administered at the end of the year. In some countries, copies of examinations from previous years are made available to teachers and students to familiarize them with the kind of examination they should expect. Armenia, Lebanon, and the Russian Federation indicated that they provide all of these kinds of curriculum support, while Sweden provides only an official curriculum guide for its teachers.

Exhibit 7.9 describes how teachers are kept abreast of changes to the official curriculum in physics in their school system. All of the TIMSS Advanced 2008 countries reported documenting such changes on the Ministry of Education's website and making various forms of in-service education and professional development opportunities available to teachers. Other activities carried out in five or more countries included conducting special conferences or seminars for teachers, distributing copies of revised curricula to schools, issuing notices to schools about recent changes to the curriculum, and publishing announcements of changes in professional association newsletters and in journals for teachers.

Exhibit 7.8 shows that, in Sweden, copies of the official curriculum were made available in printed form to teachers and others, but that none of the other alternatives listed were supported. Exhibit 7.9, on the other hand, shows that Sweden makes use of six of the eight listed alternatives for helping teachers to stay up-to-date with curricular changes. All but one of the countries indicated that they used five or more of the ways listed. Slovenia mentioned only three.

Exhibit 7.9 **Ways in Which Changes in the Curriculum Are Communicated to Teachers**

TIMSSAdvanced 2008 Physics

Country	Special Conferences/ Seminars	Ministry Website	Printed Copies of the Curriculum Distributed to Schools	Teachers Receive Own Printed Copy	Professional Development/ Inservice Education	Ministry Notes	Professional Association Newsletter	Education Journals
Armenia	●	●	●	○	●	●	○	●
Iran, Islamic Rep. of	○	●	○	○	●	●	●	●
Italy	●	●	●	○	●	●	●	●
Lebanon	●	●	●	○	●	●	○	○
Netherlands	○	●	●	○	●	●	●	●
Norway	●	●	●	●	●	●	●	○
Russian Federation	●	●	○	○	●	●	○	●
Slovenia	●	●	○	○	●	○	○	○
Sweden	●	●	●	○	●	○	●	●

● Yes
○ No

Data provided by National Research Coordinators.

Implementation of the TIMSS Physics Curriculum

Exhibit 7.10 presents information about how many hours of classroom time are devoted each week to physics in the participating countries. The National Research Coordinators provided the estimates for the amount of time prescribed in the official curriculum, and the teachers of the students being assessed provided the information about the number of hours devoted to physics each week in their own classrooms. While the two estimates were equal only in Italy, there was a high degree of agreement in all countries except Slovenia and Sweden. That is, the estimate of class time in the intended curriculum is about the same as that in the implemented curriculum. In Slovenia, the National Research Coordinator reported that two hours of instructional time each week were to be allocated to physics according to the official curriculum, but teachers reported allocating almost three hours.

Teachers also were asked to report the percent of instructional time they devoted to the four TIMSS Advanced 2008 content domains—mechanics, electricity and magnetism, heat and temperature, and atomic and nuclear physics—as well as to other topics. As shown in Exhibit 7.11, the four TIMSS Advanced content domains together accounted for the vast majority of the instructional time available for physics in every country—in fact, 90 percent or more everywhere except in the Russian Federation and Slovenia.

The final year teachers reported that the largest proportion of class time in physics in every one of the participating countries was devoted to either mechanics or electricity and magnetism, with those two domains accounting for about half the class time or more everywhere. In Italy, almost two thirds of class time was reported to have been spent on electricity and magnetism, much more than anywhere else. The Netherlands had the most balanced time allocations

Exhibit 7.10 Weekly Hours of Intended and Implemented Instructional Time for Physics in the Final Year

TIMSSAdvanced 2008 Physics

Country	Intended Instructional Time as Prescribed in the Curriculum (in Hours per Week)	Number of Weeks Schools Are Open in a Year*	Weekly Hours of Implemented Instructional Time for Physics
Armenia	3.2	34	r 3.1 (0.00)
Iran, Islamic Rep. of	3.7	36	3.8 (0.11)
Italy	3.0	42	3.0 (0.05)
Lebanon	6.0	26	6.1 (0.09)
Netherlands	3.0**	40	2.9 (0.09)
Norway	3.7	38	3.9 (0.12)
Russian Federation	3.0–4.5	34	3.6 (0.09)
[a] Slovenia	1.7	35	2.9 (0.00)
Sweden	2.0***	38	3.2 (0.09)

Intended instructional time provided by National Research Coordinators. Implemented instructional time provided by teachers.

* Number of weeks are estimated by dividing total number of school days in a year by five.

** Instructional time is not prescribed for physics. According to the curriculum, a total of 560 hours over three years should be spent by the students on physics (including homework and instruction). About 60% on average should be spent as class time.

*** Instructional time is not prescribed in the current curriculum. The range above is an estimate based on prescriptions of instructional time from the previous curriculum averaged over three years.

a Implemented time for Slovenia includes preparation time for Matura Examination.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students.

Exhibit 7.11 Percent of Time in Physics Class Devoted to TIMSS Content During the Final Year

TIMSSAdvanced 2008 Physics

Country	Mechanics	Electricity and Magnetism	Heat and Temperature	Atomic and Nuclear Physics	Other
Armenia	r 26 (0.2)	r 29 (0.2)	r 21 (0.2)	r 18 (0.1)	r 4 (0.2)
Iran, Islamic Rep. of	42 (1.4)	14 (0.9)	10 (0.7)	24 (0.8)	10 (1.2)
Italy	14 (1.3)	65 (2.7)	7 (1.0)	12 (1.3)	2 (0.7)
Lebanon	32 (0.4)	31 (0.4)	3 (0.4)	24 (0.3)	9 (0.6)
Netherlands	29 (1.3)	22 (0.8)	15 (0.8)	25 (1.5)	9 (1.1)
Norway	38 (0.8)	30 (0.5)	6 (0.7)	15 (0.6)	10 (0.8)
Russian Federation	16 (1.0)	33 (1.3)	12 (1.0)	18 (1.2)	22 (1.3)
Slovenia	21 (0.0)	26 (0.1)	16 (0.0)	24 (0.1)	13 (0.1)
Sweden	33 (1.1)	29 (0.7)	11 (0.7)	24 (0.7)	4 (0.8)

Data provided by teachers.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students.

across the four domains. The Russian Federation gave over 20 percent of instructional time to topics other than the four TIMSS Advanced content domains, much more than in the other countries.

TIMSS Advanced asked teachers about the physics topics they taught to their students. Teachers of the assessed students were asked to indicate whether each of the TIMSS Advanced topics was *mostly taught before this year, mostly taught this year,* or *not yet taught or just introduced*. Exhibit 7.12 presents teachers' reports on the percentages of students who were taught the TIMSS Advanced physics topics prior to or during the year of the assessment. The exhibit shows, for each country, averaged across the content domains, the percentage of students whose teachers reported that the students had been taught each topic. Overall, in every country except Italy, teachers reported that at least 82 percent of their students had been taught all 17 topics. In Italy, the result was 77 percent. Results for the individual topics were correspondingly high, with the two lowest rates recorded in Italy for atomic and nuclear physics (40%) and in Lebanon for heat and temperature (43%).

As previewed in Exhibit 7.4, the participating countries were asked to indicate whether each of the TIMSS Advanced 2008 physics topics was included in their intended curriculum. As shown in Exhibit 7.12, the teachers of the TIMSS Advanced 2008 physics classes in every country were asked to indicate whether the physics students had been taught that topic. There were 17 topics in all: 7 in mechanics, 4 in electricity and magnetism, 3 in heat and temperature, and 3 in atomic and nuclear physics. The topic-by-topic responses are summarized in Exhibits 7.13 through 7.16.

Exhibit 7.13 shows that all of the partcipating countries included most of the topics (5 of 7) in the mechanics domain in their intended physics curriculum. The exceptions were that Iran did not include

Exhibit 7.12 **Average Percent of Students Taught the TIMSS Advanced 2008 Physics Topics Prior to or During the Final Year**

TIMSSAdvanced 2008 Physics

Country	Overall (17 topics)	Mechanics (7 Topics)	Electricity and Magnetism (4 topics)	Heat and Temperature (3 Topics)	Atomic and Nuclear Physics (3 Topics)
Armenia	r 87 (1.2)	r 97 (0.7)	r 98 (1.0)	r 91 (1.3)	r 77 (2.8)
Iran, Islamic Rep. of	90 (1.4)	79 (1.1)	95 (1.9)	95 (1.7)	90 (2.2)
Italy	77 (1.5)	90 (1.3)	89 (1.8)	90 (1.5)	40 (3.7)
Lebanon	82 (0.6)	96 (0.6)	96 (0.8)	43 (2.0)	91 (0.8)
Netherlands	91 (0.9)	88 (0.8)	93 (1.3)	91 (2.3)	93 (1.5)
Norway	93 (0.7)	94 (0.9)	99 (0.5)	92 (1.5)	87 (1.8)
Russian Federation	93 (0.9)	99 (0.4)	100 (0.3)	92 (1.3)	83 (2.7)
Slovenia	92 (0.1)	90 (0.0)	99 (0.1)	96 (0.1)	85 (0.2)
Sweden	87 (1.1)	94 (0.8)	96 (1.5)	84 (2.4)	72 (3.6)

Data provided by teachers.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students.

Exhibit 7.13 **Intended and Taught TIMSS Advanced 2008 Mechanics Topics**

TIMSSAdvanced 2008 Physics

Mechanics (7 topics)	Conditions of Equilibrium		Energy (K.E., P.E., and Conservation of M.E.)		Mechanical Wave Phenomena in Sound and Refraction		Forces Including Frictional Force Acting on a Moving Body	
Country	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic
Armenia	●	r 95 (0.1)	●	r 100 (0.0)	●	r 98 (1.6)	●	r 100 (0.0)
Iran, Islamic Rep. of	●	97 (1.2)	●	97 (1.5)	●	98 (1.4)	●	100 (0.0)
Italy	●	97 (1.3)	●	98 (1.1)	●	90 (3.1)	●	97 (1.3)
Lebanon	●	98 (0.8)	●	100 (0.0)	●	95 (1.4)	●	96 (1.1)
Netherlands	●	98 (1.5)	●	99 (0.8)	●	99 (0.8)	●	100 (0.0)
Norway	●	89 (4.6)	●	100 (0.0)	●	100 (0.5)	●	100 (0.0)
Russian Federation	●	99 (0.6)	●	99 (0.6)	●	99 (0.9)	●	99 (0.6)
Slovenia	●	100 (0.0)	●	99 (0.0)	●	98 (0.1)	●	100 (0.0)
Sweden	●	100 (0.0)	●	100 (0.0)	●	99 (0.7)	●	100 (0.0)

Mechanics (7 topics)	Forces Acting on a Moving Body in Circular Path		Elastic and Inelastic Collision		Relativity	
Country	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic
Armenia	●	r 100 (0.0)	●	r 100 (0.0)	●	s 84 (3.3)
Iran, Islamic Rep. of	●	98 (1.4)	○	51 (4.7)	○	11 (2.1)
Italy	●	97 (1.3)	●	97 (1.4)	●	51 (6.1)
Lebanon	●	95 (1.3)	●	99 (0.7)	●	87 (2.1)
Netherlands	●	99 (0.8)	●	96 (2.5)	○	25 (4.9)
Norway	●	100 (0.0)	●	100 (0.0)	●	71 (4.2)
Russian Federation	●	100 (0.0)	●	100 (0.0)	●	95 (1.9)
Slovenia	●	100 (0.0)	●	99 (0.0)	○	35 (0.2)
Sweden	●	100 (0.2)	●	100 (0.0)	○	61 (5.3)

● Yes ○ No

Data on intended curriculum provided by National Research Coordinators, and on implemented curriculum by teachers at the time of testing.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students. An "s" indicates data are available for at least 50% but less than 70% of the students.

Exhibit 7.14 Intended and Taught TIMSS Advanced 2008 Electricity and Magnetism Topics

TIMSSAdvanced2008 Physics

Electricity and Magnetism (4 topics)	Coulomb's Law		Electric Circuits (Ohm's and Joule's Law)		Faraday's and Lenz's Laws of Induction		Electromagnetic Radiation	
Country	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic
Armenia	●	r 100 (0.0)	●	r 100 (0.0)	●	r 98 (1.5)	●	r 93 (2.9)
Iran, Islamic Rep. of	●	95 (2.1)	●	93 (2.8)	●	94 (2.3)	●	97 (1.6)
Italy	●	97 (1.5)	●	97 (1.6)	●	95 (2.1)	●	68 (5.1)
Lebanon	●	96 (1.0)	●	97 (1.1)	●	95 (0.9)	●	96 (0.7)
Netherlands	○	78 (4.4)	●	100 (0.0)	●	99 (1.5)	●	96 (2.1)
Norway	●	100 (0.0)	●	100 (0.0)	●	100 (0.0)	●	97 (1.8)
Russian Federation	●	100 (0.0)	●	100 (0.0)	●	100 (0.2)	●	98 (1.0)
Slovenia	●	100 (0.0)	●	99 (0.1)	●	99 (0.1)	●	97 (0.2)
Sweden	●	100 (0.4)	●	96 (1.7)	●	92 (4.4)	●	96 (2.5)

● Yes ○ No

Data on intended curriculum provided by National Research Coordinators, and on implemented curriculum by teachers at the time of testing.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students.

Exhibit 7.15 Intended and Taught TIMSS Advanced 2008 Heat and Temperature Topics

TIMSSAdvanced2008 Physics

Heat and Temperature (3 topics)	Difference Between Heat and Temperature, Heat Transfer and Specific Heat Capacities, Evaporation and Condensation		Expansion of Solids and Liquids in Relation to Temperature Change, Law of Ideal Gases, First Law of Thermodynamics		Black Body Radiation and Temperature	
Country	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic
Armenia	●	r 100 (0.0)	●	r 90 (1.6)	●	r 82 (2.8)
Iran, Islamic Rep. of	●	94 (2.4)	●	95 (2.0)	●	95 (2.1)
Italy	●	97 (1.6)	●	97 (1.6)	●	75 (4.1)
Lebanon	●	57 (2.3)	○	44 (2.3)	○	27 (2.4)
Netherlands	●	93 (2.9)	●	94 (2.4)	●	87 (3.1)
Norway	●	100 (0.0)	●	98 (1.7)	●	79 (4.2)
Russian Federation	●	100 (0.0)	●	100 (0.4)	●	76 (3.9)
Slovenia	●	99 (0.0)	●	99 (0.0)	●	90 (0.2)
Sweden	●	96 (1.7)	●	76 (3.6)	●	81 (3.7)

● Yes ○ No

Data on intended curriculum provided by National Research Coordinators, and on implemented curriculum by teachers at the time of testing.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students.

Exhibit 7.16 **Intended and Taught TIMSS Advanced 2008 Atomic and Nuclear Physics Topics**

TIMSS Advanced 2008 Physics

Atomic and Nuclear Physics (3 topics)	Structure of Atom		Light Emission and Absorption		Nuclear Reactions	
Country	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic	Topic Is in the Intended Curriculum	Percent of Students Taught This Topic
Armenia	●	r 83 (3.6)	●	r 88 (3.0)	●	r 65 (2.7)
Iran, Islamic Rep. of	●	95 (2.2)	●	96 (2.0)	●	79 (3.7)
Italy	●	64 (4.9)	●	41 (5.5)	●	14 (4.3)
Lebanon	●	95 (0.6)	●	95 (1.1)	●	81 (1.6)
Netherlands	●	96 (1.8)	●	92 (3.0)	●	89 (1.8)
Norway	●	97 (1.7)	●	67 (4.9)	●	98 (1.3)
Russian Federation	●	88 (2.6)	●	89 (3.2)	●	72 (3.9)
Slovenia	●	92 (0.2)	●	86 (0.2)	●	77 (0.2)
Sweden	●	73 (4.3)	●	86 (3.3)	●	56 (5.7)

● Yes ○ No

Data on intended curriculum provided by National Research Coordinators, and on implemented curriculum by teachers at the time of testing.

( ) Standard errors appear in parentheses.

An "r" indicates data are available for at least 70% but less than 85% of the students.

elastic and inelastic collisions, and relativity was not included in Iran, the Netherlands, Slovenia, or Sweden. Generally speaking, the TIMSS Advanced topics in mechanics corresponded to those included in the intended curriculum and taught to a large proportion of the students.

Exhibit 7.14 shows that all four topics in the TIMSS Advanced 2008 electricity and magnetism domain were included in the intended curriculum of all these countries, with one exception. The Netherlands reported that Coulomb's Law was not in their intended curriculum, although, according to teachers' reports, almost 80 percent of students had been taught about it. In Italy, although electromagnetic radiation was reported to be in the intended curriculum, about one third of students were not taught about it.

Exhibit 7.15 focuses on the heat and temperature domain. All three topics were part of the intended curriculum in all countries except Lebanon where two of the three topics were not. Lebanon was also the only country where these three topics were not part of the implemented curriculum for many students. Otherwise, all three topics were taught to almost all students.

Exhibit 7.16 presents the intended and implemented results for the three topics in atomic and nuclear physics. All three were in the intended curriculum of every country, and in the implemented curriculum for the majority of students everywhere, with the exception of Italy, where only 41 percent were reported to have been taught about light emission and absorption and only 14 percent about nuclear reactions.

How Well Prepared Do Teachers Feel They Are to Teach Physics?

TIMSS Advanced 2008 asked the physics teachers how well prepared they felt they were to teach the topics included in the physics framework. For each topic, teachers were asked to indicate whether they felt very well prepared, somewhat prepared, or not well prepared. Teachers were asked about 17 topics in total, including 7 topics in mechanics, 4 topics in electricity and magnetism, 3 topics in heat and temperature, and 3 topics in atomic and nuclear physics. The percentages of students whose teachers reported feeling very well prepared to teach the various topics are presented in Exhibits 7.17 and 7.18. In Exhibit 7.17, the results are summarized by averaging the percentages of students whose teachers reported feeling very well prepared to teach each topic first across all of the 17 physics topics, and next across the topics in each of the four content domains. Exhibit 7.18 presents the results for each topic.

Exhibit 7.17 makes it clear that, in most of the participating countries, the vast majority of students were taught by teachers who considered themselves to be very well prepared to teach these physics topics at this level. This result is not particularly surprising, but there may be some cause for concern in those countries where 20 percent or more of the students were taught by teachers who considered themselves only somewhat prepared or not well prepared to teach these 17 topics. Over 80 percent of the students in Iran, Lebanon, the Netherlands, Norway, and Sweden were taught by teachers who considered themselves well prepared, on average, to teach the TIMSS Advanced topics. On the other hand, more than 20 percent of students in Armenia, Italy, and Slovenia were taught by teachers who were not as confident about their degree of preparedness.

Exhibit 7.18 shows the percent of students whose teachers considered themselves to be very well prepared to teach the topics in

Exhibit 7.17 **Percent of Students Whose Teachers Feel "Very Well" Prepared to Teach the TIMSS Advanced 2008 Physics Topics**

TIMSSAdvanced 2008 Physics

Country	Percent of Students				
	Overall (17 topics)	Mechanics (7 topics)	Electricity and Magnetism (4 topics)	Heat and Temperature (3 topics)	Atomic and Nuclear Physics (3 topics)
Armenia	78 (0.6)	80 (0.4)	82 (1.1)	81 (1.2)	68 (1.7)
Iran, Islamic Rep. of	86 (1.3)	81 (1.4)	92 (1.5)	91 (1.9)	78 (2.0)
Italy	42 (4.2)	50 (4.8)	49 (4.7)	47 (5.1)	22 (3.9)
Lebanon	86 (1.0)	92 (0.9)	92 (1.1)	66 (1.9)	93 (1.1)
Netherlands	84 (2.8)	80 (2.8)	83 (3.1)	85 (3.0)	87 (3.1)
Norway	93 (1.4)	94 (1.3)	96 (1.4)	90 (2.5)	92 (2.1)
Russian Federation	– –	– –	– –	– –	– –
Slovenia	76 (0.2)	77 (0.1)	80 (0.2)	78 (0.2)	70 (0.2)
Sweden	86 (1.7)	90 (1.5)	90 (2.1)	77 (2.7)	88 (2.4)

Data provided by teachers.

A dash (-) indicates comparable data are not available. The Russian Federation did not collect this information.

( ) Standard errors appear in parentheses.

the four TIMSS Advanced 2008 physics content domains on a topic-by-topic basis. One might expect that almost all physics teachers at this level would consider themselves well qualified, insofar as the subject matter of the course is concerned, and that such teachers would feel themselves to be very well prepared to teach the course. This turns out, surprisingly enough, not to be the case for every topic in every country, and this is reflected in the content of the four tables that make up the exhibit: one table for each of the four content domains.

If 80 percent or more is used as a criterion for countries where a large majority of students were taught by teachers who considered themselves to be very well prepared to teach a topic, all of the mechanics topics except relativity would be included except in Italy. In Italy, large proportions of the teachers reported that they did not feel very well prepared to teach any of the mechanics topics.

The second table in Exhibit 7.18 concerns the four electricity and magnetism topics, and it raises similar issues. All four are areas in which a large majority of students of physics were taught by teachers who felt they were well prepared to do so. This, however, was not true in Italy, where significant proportions of physics teachers said they did not consider themselves very well prepared to teach the electricity and magnetism topics.

The third table in the exhibit deals with the three topics grouped under heat and temperature. Here again, large proportions of students in Italy were taught by teachers who considered themselves less than very well prepared to teach these topics. Moreover, many teachers in most countries expressed a relative lack of confidence in their preparedness to teach the topic of black body radiation and temperature, even though the topic was included in the intended curriculum in every country and most students were taught it.

Exhibit 7.18 **Percent of Students Whose Teachers Feel "Very Well" Prepared to Teach the TIMSS Advanced 2008 Physics Topics in Mechanics, Electricity and Magnetism, Heat and Temperature, and Atomic and Nuclear Physics**

TIMSSAdvanced 2008 Physics

Country	Percent of Students Whose Teachers Report Feeling Very Well Prepared to Teach the Topics in Mechanics (7 topics)						
	Conditions of Equilibrium	Energy (K.E., P.E., and Conservation of M.E.)	Mechanical Wave Phenomena in Sound and Refraction	Forces Including Frictional Force Acting on a Moving Body	Forces Acting on a Moving Body in Circular Path	Elastic and Inelastic Collision	Relativity
Armenia	83 (2.1)	97 (0.1)	81 (1.8)	91 (0.3)	84 (0.4)	74 (0.5)	48 (0.7)
Iran, Islamic Rep. of	92 (2.7)	99 (0.6)	92 (2.7)	97 (1.3)	88 (2.8)	73 (3.7)	24 (3.7)
Italy	55 (5.6)	61 (5.7)	43 (5.9)	61 (5.5)	55 (5.8)	56 (5.3)	19 (4.2)
Lebanon	96 (0.8)	97 (0.8)	91 (1.3)	94 (1.2)	93 (1.4)	95 (1.2)	77 (2.5)
Netherlands	90 (3.3)	91 (3.0)	87 (3.8)	92 (2.8)	87 (3.7)	82 (3.7)	31 (4.8)
Norway	92 (2.3)	99 (1.0)	96 (1.8)	99 (1.0)	99 (1.0)	95 (2.2)	78 (3.9)
Russian Federation	– –	– –	– –	– –	– –	– –	– –
Slovenia	90 (0.2)	84 (0.2)	82 (0.2)	90 (0.2)	76 (0.2)	78 (0.2)	42 (0.2)
Sweden	96 (1.9)	97 (1.7)	89 (2.7)	95 (2.1)	96 (1.6)	97 (1.5)	59 (4.7)

Country	Percent of Students Whose Teachers Report Feeling Very Well Prepared to Teach the Topics in Electricity and Magnetism (4 topics)			
	Coulomb's Law	Electric Circuits (Ohm's and Joule's Law)	Faraday's and Lenz's Laws of Induction	Electromagnetic Radiation
Armenia	91 (0.4)	89 (2.5)	80 (3.2)	69 (1.9)
Iran, Islamic Rep. of	98 (1.3)	83 (3.7)	96 (1.8)	91 (2.4)
Italy	62 (5.5)	51 (5.7)	58 (5.9)	26 (5.2)
Lebanon	94 (1.3)	92 (1.4)	92 (1.5)	90 (1.3)
Netherlands	81 (3.8)	87 (3.4)	81 (3.4)	83 (3.9)
Norway	99 (1.1)	93 (2.7)	97 (1.7)	96 (2.1)
Russian Federation	– –	– –	– –	– –
Slovenia	88 (0.2)	82 (0.2)	81 (0.2)	69 (0.2)
Sweden	94 (2.2)	82 (4.8)	91 (2.1)	93 (2.1)

Data provided by teachers.

A dash (–) indicates comparable data are not available. The Russian Federation did not collect this information.

( ) Standard errors appear in parentheses.

Exhibit 7.18 **Percent of Students Whose Teachers Feel "Very Well" Prepared to Teach the TIMSS Advanced 2008 Physics Topics in Mechanics, Electricity and Magnetism, Heat and Temperature, and Atomic and Nuclear Physics (Continued)**

TIMSSAdvanced 2008 Physics

Country	Percent of Students Whose Teachers Report Feeling Very Well Prepared to Teach the Topics in Heat and Temperature (3 topics)		
	Difference Between Heat and Temperature, Heat Transfer and Specific Heat Capacities, Evaporation and Condensation	Expansion of Solids and Liquids in Relation to Temperature Change, Law of Ideal Gases, First Law of Thermodynamics	Black Body Radiation and Temperature
Armenia	87 (2.0)	92 (2.8)	64 (2.4)
Iran, Islamic Rep. of	97 (1.8)	94 (2.3)	83 (3.4)
Italy	59 (6.0)	56 (6.1)	27 (5.1)
Lebanon	81 (1.8)	72 (2.4)	45 (2.6)
Netherlands	90 (3.2)	86 (3.4)	80 (3.6)
Norway	94 (2.4)	88 (3.0)	89 (3.2)
Russian Federation	– –	– –	– –
Slovenia	80 (0.2)	84 (0.2)	68 (0.2)
Sweden	92 (2.2)	61 (4.3)	78 (4.2)

Country	Percent of Students Whose Teachers Report Feeling Very Well Prepared to Teach the Topics in Atomic and Nuclear Physics (3 topics)		
	Structure of Atom	Light Emission and Absorption	Nuclear Reactions
Armenia	78 (2.3)	78 (2.1)	51 (4.1)
Iran, Islamic Rep. of	96 (1.8)	93 (1.9)	46 (4.1)
Italy	29 (5.5)	25 (4.5)	12 (3.3)
Lebanon	94 (1.0)	93 (1.2)	92 (1.2)
Netherlands	89 (3.1)	88 (3.1)	83 (3.6)
Norway	96 (1.8)	95 (1.9)	84 (3.9)
Russian Federation	– –	– –	– –
Slovenia	79 (0.2)	66 (0.3)	64 (0.2)
Sweden	91 (2.9)	91 (3.2)	81 (2.9)

Data provided by teachers.

A dash (–) indicates comparable data are not available. The Russian Federation did not collect this information.

( ) Standard errors appear in parentheses.

The final table in Exhibit 7.18 deals with atomic and nuclear physics. In this content domain, Italy reported significant percentages of students taught by teachers who did not consider themselves very well prepared to teach this material, even though these topics were included in their intended curriculum.

In summary, Chapter 7 presents a considerable amount of important information that should be taken into account when considering the achievement results presented in Chapter 8. Many country characteristics, such as socioeconomic factors and population size, can affect the challenges associated with educating students in physics. Beyond that, in some countries, students have had more years of schooling, or the physics program entails many more hours of study across the years of the program. In some cases, countries were more selective than others in identifying the students to be assessed in TIMSS Advanced. Also, the curriculum differed somewhat across the physics programs assessed in TIMSS Advanced, as did teachers' confidence in their preparation to teach the topics assessed. The considerable variation across the nine participating countries in these system-wide contexts for educating students in physics provides a complex and multifaceted backdrop for considering the variation in physics achievement.

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