

Chapter 5

Advanced Mathematics Teachers and Instruction in Mathematics

To help place students' achievement in advanced mathematics in the context of their school and classroom situations, TIMSS Advanced asked students' teachers to complete questionnaires about their educational preparation to teach advanced mathematics, their school and classroom situations, and the instructional practices they used in teaching advanced mathematics to the students assessed. This chapter begins by presenting teachers' reports about their background characteristics, education, and participation in professional activities and development. The second part of the chapter provides information about a number of aspects of their pedagogical approach to the teaching of mathematics, including the predominant learning activities and technology used as well as the roles of homework and assessment.

Results are generally shown as the percentages of students whose teachers reported various situations. That is, the student is the unit of analysis so that TIMSS Advanced 2008 can describe the students' classroom contexts. The exhibits have special notations when relatively large percentages of students did not have teacher questionnaire information. For a country where teacher responses were available for 70 to 84 percent of the students, an "r" is included next to its data,



and in rare cases where teacher responses were available for 50 to 69 percent of students, an “s” is included.

Background Characteristics of Advanced Mathematics Teachers

This section presents information about the background characteristics of the teachers of advanced mathematics, including gender, age, and years of teaching experience. As shown in Exhibit 5.1, Italy was the only country in which approximately equal proportions of advanced mathematics students were taught by male and female mathematics teachers: 54 percent female, and 46 percent male. In the other participating countries there was a clear majority in favor of one gender over the other. In Armenia, the Philippines, the Russian Federation, and Slovenia, most teachers at this level were women. In Iran, Lebanon, the Netherlands, Norway, and Sweden, most were men. At the extremes, in the Russian Federation, 90 percent of the advanced mathematics students were taught by women; while in Lebanon, 90 percent were taught by men.

Exhibit 5.1 also presents teachers' reports about their age and teaching experience. Perhaps the most striking feature of these results is that two thirds or more of the advanced mathematics students in Lebanon, the Netherlands, and Norway were taught by teachers who were at least 50 years old. In Sweden, the figure was almost 60 percent and in Armenia and Italy was about 45 percent. On the other hand, 55 percent of Iranian students and 61 percent of Philippine students were taught by teachers less than 40 years old. The Philippines had by far the greatest percent of students being taught by teachers less than 30 years old.

As might be expected, the advanced mathematics students were taught by highly experienced teachers. Reported years of experience ranged from a low of 14 years in the Philippines, who had a much

Exhibit 5.1 **Advanced Mathematics Teachers' Gender, Age, and Number of Years Teaching**

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Country	Percent of Students by Teacher Characteristics						Average Number of Years Teaching	
	Gender		Age				Teaching Altogether	Teaching Mathematics at the Advanced Level
	Female	Male	29 Years or Under	30–39 Years	40–49 Years	50 Years or Older		
Armenia	76 (4.6)	24 (4.6)	0 (0.0)	10 (2.4)	44 (5.4)	46 (5.4)	25 (0.9)	13 (1.2)
Iran, Islamic Rep. of	33 (2.5)	67 (2.5)	6 (2.3)	49 (3.8)	31 (3.4)	13 (2.5)	17 (0.6)	9 (0.3)
Italy	54 (5.4)	46 (5.4)	2 (1.4)	10 (3.0)	43 (4.7)	45 (4.6)	22 (0.9)	12 (0.8)
Lebanon	10 (1.5)	90 (1.5)	3 (0.9)	13 (1.9)	20 (2.0)	65 (2.4)	27 (0.5)	25 (0.5)
Netherlands	14 (3.5)	86 (3.5)	3 (2.0)	10 (2.1)	20 (4.8)	67 (5.2)	27 (1.1)	17 (1.1)
Norway	18 (3.9)	82 (3.9)	1 (0.7)	8 (2.3)	19 (4.2)	73 (4.3)	27 (0.9)	26 (0.9)
Philippines	63 (4.4)	37 (4.4)	25 (4.2)	36 (4.4)	25 (4.5)	14 (3.8)	14 (1.0)	5 (0.5)
Russian Federation	90 (2.7)	10 (2.7)	1 (0.6)	13 (3.0)	36 (5.2)	51 (5.2)	26 (0.8)	12 (0.8)
Slovenia	76 (5.1)	24 (5.1)	4 (1.9)	34 (5.8)	32 (5.9)	30 (5.5)	18 (1.1)	14 (0.7)
Sweden	19 (3.8)	81 (3.8)	2 (1.1)	18 (4.0)	22 (3.3)	58 (4.0)	22 (1.0)	9 (0.7)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

() Standard errors appear in parentheses.

Exhibit 5.2 **Teachers' Plans to Continue Teaching Advanced Mathematics**

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Country	Percent of Students by Their Teachers' Plans to Continue Teaching			
	Plan to Continue Teaching as Long as I Can	Plan to Continue Teaching Until the Opportunity for a Better Job in Education Comes Along	Plan to Continue Teaching for Awhile But Probably Will Leave the Field of Education	Undecided at This Time
Armenia	87 (2.7)	1 (0.0)	0 (0.0)	12 (2.7)
Iran, Islamic Rep. of	84 (2.9)	10 (2.4)	2 (1.1)	4 (1.4)
Italy	84 (3.7)	8 (2.5)	3 (2.2)	5 (2.2)
Lebanon	80 (1.9)	12 (1.5)	3 (0.9)	5 (1.2)
Netherlands	93 (2.6)	2 (1.8)	2 (1.7)	2 (1.7)
Norway	79 (5.2)	1 (1.0)	2 (1.4)	18 (5.0)
Philippines	75 (4.8)	17 (4.1)	3 (1.1)	5 (2.7)
Russian Federation	73 (4.1)	1 (1.0)	8 (2.2)	18 (3.7)
Slovenia	58 (5.6)	5 (2.0)	1 (1.0)	35 (5.7)
Sweden	67 (3.8)	4 (2.3)	6 (2.6)	24 (4.3)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

larger proportion of younger teachers than was the case in other countries, to a high of 27 years in Lebanon, the Netherlands, and Norway. Teachers in Armenia (25 years) and the Russian Federation (26 years) were nearly as experienced. Interestingly, teachers in Lebanon and Norway had spent nearly all of their careers teaching advanced mathematics, while in other countries teachers typically reported that only about half of their total years teaching had been spent teaching advanced mathematics.

Teachers were also asked about their plans for the future, insofar as teaching advanced mathematics was concerned. The results, shown in Exhibit 5.2, indicate that most of the advanced mathematics teachers in these countries plan to continue their teaching careers, although significant percentages in some countries—18 percent in Norway and the Russian Federation, 24 percent in Sweden, and 35 percent in Slovenia—were undecided about their future plans. Few teachers in any of the participating countries indicated that they planned to leave the field of education or even that they planned to look for a different position within the field of education. It appears that teachers of advanced mathematics in these countries like their jobs and plan to continue in them at least for a while.

Teacher Education for Teaching Advanced Mathematics

Exhibit 5.3 indicates that virtually every teacher of advanced mathematics in all of the participating countries had a university degree, either at the undergraduate or graduate level. Students in all countries had highly educated teachers (with the possible exception of 5 percent in Lebanon and 1 percent in Norway). In general, the teachers of advanced mathematics in the participating countries who had completed postgraduate university degrees had from five to seven years of university study or even more. Essentially all advanced

Exhibit 5.3 Highest Educational Level of Advanced Mathematics Teachers*



Country	Percent of Students by Their Teachers' Educational Level		
	Completed Postgraduate University Degree**	Completed University But Not a Postgraduate Degree***	Did Not Complete University
Armenia	97 (0.1)	3 (0.1)	0 (0.0)
Iran, Islamic Rep. of	27 (3.3)	73 (3.3)	0 (0.0)
Italy	12 (3.2)	88 (3.2)	0 (0.0)
Lebanon	43 (2.4)	52 (2.5)	5 (0.9)
^a Netherlands	65 (5.2)	35 (5.2)	0 (0.0)
^b Norway	71 (4.7)	29 (4.7)	1 (0.6)
Philippines	32 (4.5)	68 (4.5)	0 (0.0)
^c Russian Federation	79 (3.6)	21 (3.6)	0 (0.0)
^d Slovenia	100 (0.0)	0 (0.0)	0 (0.0)
Sweden	48 (5.2)	52 (5.2)	0 (0.0)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

* Based on countries' categorization to UNESCO's International Standard Classification of Education (Operational Manual for ISCED-1997).

** Level 5A, second degree or higher on the ISCED scale.

*** Level 5A, first degree on the ISCED scale.

^a In the Netherlands, most teachers who have completed a postgraduate university degree have a university degree in mathematics or physics requiring 3 years of study at the bachelor's level and 2 years at the master's level, and one year of special teacher training. Recently, it has been possible to obtain a 2-year "education master" equivalent to a master's degree. Also, a few teachers in this category have a PhD. Teachers who have completed university but not a postgraduate degree have completed 4 years at a teacher training institute (or college) and obtained a diploma equivalent to a bachelor's degree. To be a teacher at the advanced level of the pre-university track, it also is necessary to complete postgraduate work at a teacher

training institute, but this is not considered equivalent to a university's master's degree.

- ^b Norwegian teachers who have completed postgraduate study typically have master's degrees requiring 5–7 years of university study.
 - ^c In the Russian Federation, teachers with a postgraduate university degree have completed 5–6 years of higher education, ending with defending a thesis to obtain a diploma (equivalent to a master's degree), and also have passed state examinations. Some teachers in this category may have two diplomas or a doctoral degree.
 - ^d Slovenian teachers all have obtained a diploma based on completing 4 years of university study followed by a successful thesis (equivalent to a master's degree). Some have a master's degree based on an additional 2 years of study or a doctoral degree based on 4 years of additional study.
- () Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.

mathematics students in Armenia and Slovenia had teachers who had completed postgraduate study as did 79 percent in the Russian Federation, 71 percent in Norway, and 65 percent in the Netherlands.

Teachers were asked to indicate which, from a list of several choices, had been a “major or main area(s) of study” for them in their post-secondary studies. The options available were mathematics, mathematics education, physics, science education, engineering, general education, and other. Teachers were free to identify more than one main area of study, so the percents for each country total more than 100. The results are presented in Exhibit 5.4.

Eighty-five percent or more of the students in six countries had teachers that had specialized in mathematics, including Armenia, Iran, Norway, the Russian Federation, Slovenia, and Sweden. Also, two thirds or more had teachers that had specialized in mathematics education in six countries, including Armenia, Lebanon, the Netherlands, the Philippines, the Russian Federation, and Sweden. The results indicate that the majority of students in all of the participating countries had teachers with mathematics or mathematics education or both as major or main areas of concentration in their post-secondary education. In Norway (63%) and Sweden (70%), substantial proportions of advanced mathematics students had teachers that also said that physics had been a main area of their program. The teachers of Italian students, for the most part, appear to have specialized either in mathematics or physics.

Exhibit 5.5 presents brief descriptions of national requirements for being a teacher of advanced mathematics in each of the participating countries. There is a high degree of commonality across all of these descriptions. Basically, teachers of advanced mathematics in all of these countries are required to have an extensive tertiary level academic background in mathematics and in teacher education. Passing an examination is a requirement in four of the countries—Italy, Lebanon, the Philippines, and Slovenia.

Exhibit 5.4 Teachers’ Major or Main Area(s) of Study

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Country	Percentage of Students by Their Teachers’ Major or Main Area(s) of Study in Their Post-secondary Education						
	Mathematics	Education–Mathematics	Physics	Education–Science	Engineering	Education–General	Other
Armenia	96 (1.6)	77 (3.6)	24 (4.2)	4 (2.4)	0 (0.0)	25 (4.9)	13 (4.2)
Iran, Islamic Rep. of	85 (3.0)	46 (3.9)	1 (0.9)	5 (1.8)	9 (2.7)	6 (2.1)	6 (1.8)
Italy	64 (5.3)	--	30 (4.8)	--	5 (2.3)	--	35 (5.2)
Lebanon	62 (2.2)	82 (1.9)	12 (1.2)	6 (1.3)	4 (1.1)	12 (1.5)	12 (1.5)
Netherlands	49 (5.1)	72 (4.1)	13 (3.7)	2 (1.1)	4 (2.0)	--	19 (4.7)
Norway	98 (1.2)	6 (2.7)	63 (4.6)	1 (1.1)	12 (3.2)	24 (4.8)	65 (4.4)
Philippines	65 (4.4)	71 (5.1)	6 (2.1)	3 (1.6)	12 (3.3)	22 (5.0)	11 (4.9)
Russian Federation	100 (0.2)	68 (4.0)	16 (2.7)	12 (2.7)	12 (3.1)	46 (4.6)	12 (2.6)
Slovenia	92 (3.2)	9 (3.1)	3 (1.9)	3 (1.9)	3 (1.8)	0 (0.0)	1 (0.6)
Sweden	86 (3.4)	67 (4.5)	70 (4.3)	41 (5.3)	14 (4.1)	20 (4.1)	19 (4.9)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

A dash (–) indicates comparable data are not available.

() Standard errors appear in parentheses.

Exhibit 5.5 National Requirements for Being a Teacher of Advanced Mathematics

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Country	Requirements
Armenia	Teachers need the Certificate of Higher Education, with certificates of mathematics education and of professional development in advanced mathematics highly desirable.
Iran, Islamic Rep. of	Teachers need at least a bachelor’s degree in mathematics.
Italy	Teachers need to have taken a national examination and completed a degree in mathematics, physics, or engineering.
Lebanon	Teachers must have a degree in mathematics, pass an admission examination to a Faculty of Pedagogy at Lebanese University, and complete 2 years of pedagogical study.
Netherlands	Teachers either have a university master’s degree in mathematics followed by a 1-year university education course, or have attended a polytechnic college obtaining a bachelor’s degree in mathematics (education) followed by a master’s course in mathematics education.
Norway	Teachers are required to have a university bachelor’s degree consisting of 1 full year (60 credit points) of mathematics courses. They also need 1 year of teacher education courses, consisting of general pedagogy, mathematics education, and teaching practice in schools.
Philippines	Teachers must be at least an education graduate, major in mathematics, pass the licensure exam for teachers (LET), and be literate in using ICT technology in teaching.
Russian Federation	Teachers need the Certificate of Higher Education, with certificates of mathematics education and of professional development in advanced mathematics highly desirable.
Slovenia	To obtain a teaching license, it is necessary to complete mathematics study together with some pedagogical courses at the Faculty for Mathematics and Physics, teach under supervision of a seminar teacher for 1 year, and pass a teaching certification examination organized by the ministry.
Sweden	Teachers of advanced mathematics have at least 1 year of university study in mathematics as well as a total of at least 3.5–4 years of study in academic subject areas. A degree in teacher education is also expected.

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by National Research Coordinators.

Advanced Mathematics Teachers' Professional Activities and Development

Teachers in most countries have a choice of a number of professional associations or organizations available to them. They may, as a condition of employment, be required to join, or at least pay membership dues to, the teachers' union that bargains with their employers regarding salaries, working conditions, and the like. However, they may also choose to become members of a professional association, either local or national, that brings together teachers with similar backgrounds and interests to discuss professional matters and promote the cause of mathematics education, for example.

As the results in Exhibit 5.6 make clear, teachers of advanced mathematics in the countries participating were unlikely to belong to a professional organization of mathematics teachers and even less likely to participate regularly in activities sponsored by such organizations. The Netherlands had the largest percentage of students (69%) being taught advanced mathematics by a teacher who belonged to a professional organization of mathematics teachers, and in six countries less than 40 percent of the students were taught by teachers belonging to such an organization. Results regarding participation in professional activities were not any more encouraging. Apparently, teachers of advanced mathematics in these countries do not have the opportunity to join professional organizations or do not see much need to join such organizations or to participate in activities sponsored by them.

The teachers of advanced mathematics were presented with five statements relating to their participation in a range of professional activities. The activities included attending workshops or conferences, making a presentation at a workshop or conference, having an article published in a journal or magazine directed at teachers, taking part in

Exhibit 5.6 **Teachers' Participation in a Professional Organization for Mathematics Teachers**


Country	Percent of Students Whose Teacher Was a Member of a Professional Organization for Mathematics Teachers	Percent of Students Whose Teacher Regularly Participated in Activities Sponsored by a Professional Organization for Mathematics Teachers
Armenia	33 (3.4)	40 (3.2)
Iran, Islamic Rep. of	34 (3.8)	26 (3.6)
Italy	18 (3.7)	29 (4.9)
Lebanon	26 (2.2)	38 (2.2)
Netherlands	69 (5.9)	34 (5.5)
Norway	15 (5.0)	8 (3.1)
Philippines	57 (5.4)	67 (5.2)
Russian Federation	55 (3.6)	18 (3.0)
Slovenia	51 (5.7)	43 (5.5)
Sweden	24 (5.1)	12 (3.3)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

() Standard errors appear in parentheses.

an innovative project for curriculum and instruction, and exchanging information online about teaching mathematics. Students whose teachers had participated in three or more of these activities were categorized at the high level of participation. Those whose teachers had not participated in any of these activities were categorized at the low level, and all the rest were categorized at the medium level.

The information about teachers' participation in professional activities is summarized in Exhibit 5.7. In the table, the countries are presented in descending order of the percentage of students whose teachers were classified at the high level of participation. Also, the results are presented in relation to students' average achievement, although there was little relationship between more participation by teachers and higher achievement except in the Russian Federation.

In the Russian Federation, Slovenia, and the Philippines, less than 10 percent of students were taught by teachers who were classified at the low level of participation in professional activities; all the rest, over 90 percent, were taught by teachers who reported a high or medium level of participation. Results from the other countries were rather disappointing, with over 20 percent of students in six countries taught by teachers who had low levels of participation. In Norway, this was the case for 44 percent of the students.

Another questionnaire item asked teachers whether or not they had participated in professional development in one or more of six areas related to mathematics teaching in the previous two years. The areas were: mathematics content, mathematics pedagogy or instruction, mathematics curriculum, integrating information technology into mathematics, improving students' critical thinking or problem-solving skills, and mathematics assessment.

The results presented in Exhibit 5.8 indicate that in 8 of the 10 countries (everywhere except Lebanon and Norway) the most

Exhibit 5.7 Index of Teachers' Participation in Professional Activities in Mathematics (PAM)

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Country	High PAM		Medium PAM		Low PAM	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Russian Federation	46 (4.6)	575 (9.4)	49 (4.6)	552 (10.0)	5 (1.8)	524 (12.3)
Slovenia	30 (5.9)	460 (10.3)	61 (5.9)	458 (6.0)	8 (2.8)	450 (11.2)
Philippines	24 (4.5)	350 (13.4)	68 (4.8)	359 (7.9)	8 (3.2)	342 (32.4)
Iran, Islamic Rep. of	22 (3.1)	502 (16.6)	61 (3.6)	487 (7.3)	18 (2.8)	524 (11.7)
Lebanon	17 (2.1)	548 (5.7)	45 (2.4)	546 (3.0)	38 (2.0)	543 (3.9)
Norway	13 (3.6)	447 (8.5)	43 (5.1)	444 (8.1)	44 (5.7)	432 (7.6)
Armenia	12 (3.4)	440 (31.7)	56 (4.5)	437 (10.0)	32 (2.9)	429 (7.3)
Sweden	12 (3.9)	411 (26.5)	63 (5.4)	417 (6.1)	25 (4.9)	413 (8.3)
Italy	10 (3.1)	427 (24.1)	65 (4.7)	453 (8.4)	25 (4.4)	445 (15.9)
Netherlands	9 (3.2)	553 (9.1)	71 (5.1)	554 (2.4)	20 (4.1)	550 (4.7)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on teachers' responses to five statements about their participation in professional activities: 1) Attended a workshop or conference; 2) Gave a presentation at a workshop or conference; 3) Published an article in a journal or magazine for teachers (print or online); 4) Took part in an innovative project for curriculum and instruction; and 5) Exchanged information online about how to teach mathematics. Students whose teachers

participated in three or more of the five activities were assigned to the high level. Students whose teachers did not participate in any activities were assigned to the low level. All other students were assigned to the medium level.

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

Exhibit 5.8 Teachers' Participation in Professional Development

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Country	Percent of Students Whose Teachers Participated in Professional Development in Various Areas of Mathematics in the Past Two Years					
	Mathematics Content	Mathematics Pedagogy/ Instruction	Mathematics Curriculum	Integrating Information Technology into Mathematics	Improving Students' Critical Thinking or Problem-solving Skills	Mathematics Assessment
Armenia	81 (3.4)	87 (1.7)	75 (4.3)	44 (4.2)	57 (5.0)	67 (4.5)
Iran, Islamic Rep. of	45 (3.7)	63 (3.7)	34 (3.7)	25 (3.1)	29 (3.2)	24 (3.3)
Italy	46 (5.4)	50 (5.6)	19 (4.2)	39 (4.5)	15 (3.6)	19 (3.9)
Lebanon	33 (2.3)	36 (2.4)	27 (2.1)	29 (1.9)	41 (2.3)	42 (2.8)
Netherlands	62 (4.7)	36 (5.9)	41 (6.6)	25 (4.9)	12 (3.6)	6 (2.4)
Norway	42 (4.6)	31 (4.8)	47 (4.5)	53 (5.3)	6 (2.1)	26 (4.0)
Philippines	84 (3.8)	75 (3.9)	70 (4.0)	58 (4.0)	58 (4.9)	--
Russian Federation	79 (5.1)	68 (3.8)	66 (4.3)	72 (4.3)	55 (4.5)	57 (4.5)
Slovenia	88 (3.4)	81 (3.6)	52 (5.8)	66 (5.3)	42 (6.7)	68 (5.9)
Sweden	51 (5.3)	52 (6.0)	33 (4.3)	34 (5.2)	32 (3.8)	52 (4.6)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

(1) Standard errors appear in parentheses.

common professional development activities for teachers focused on either mathematics content or mathematics pedagogy and instruction. In general, significantly greater percentages of students in Armenia, the Philippines, the Russian Federation, and Slovenia were taught by teachers who had participated in professional development related to mathematics teaching within the past two years than in the other six countries.

Previous cycles of TIMSS have shown that the extent of professional collaboration among mathematics teachers in the same school varies widely across countries, and Exhibit 5.9 shows that the same is true for teachers of advanced mathematics in the participating countries. On a positive note, the results show that the majority of students in every country were taught by teachers who consulted with colleagues in their school about pedagogical matters several times each month. In fact, in six countries, more than 80 percent of students had teachers that met with their colleagues at least several times a month or even weekly. On the other hand, more than a third of students in Iran, Italy, the Netherlands, and Slovenia were taught by teachers who rarely, if ever, consulted with colleagues in their school about pedagogical matters such as how to teach a particular concept, worked collegially to prepare instructional materials, observed a colleague's teaching, or invited a colleague to observe their teaching.

Exhibit 5.10 presents school principals' reports about how teachers of advanced mathematics were evaluated in each of the participating countries. The results are shown in terms of the percentage of students in each country taught by teachers who were evaluated on the basis of classroom observations by the school principal or a senior staff member, classroom observations by an external examiner or inspector, student achievement, or teacher peer reviews.

Exhibit 5.9 Frequency of Collaboration Among Advanced Mathematics Teachers



Country	Percent of Students by Their Teachers' Frequency of Collaboration with Other Teachers		
	At Least Weekly	2 or 3 Times per Month	Never or Almost Never
Armenia	30 (3.5)	70 (3.6)	1 (1.0)
Iran, Islamic Rep. of	7 (2.3)	59 (4.2)	35 (4.2)
Italy	7 (2.7)	53 (3.9)	39 (4.2)
Lebanon	17 (1.9)	64 (1.9)	19 (1.7)
Netherlands	0 (0.0)	55 (5.0)	44 (5.0)
Norway	9 (2.1)	72 (4.4)	19 (4.1)
Philippines	16 (3.9)	73 (3.9)	12 (3.1)
Russian Federation	35 (3.5)	59 (4.2)	6 (2.0)
Slovenia	4 (1.6)	53 (5.9)	43 (5.8)
Sweden	9 (3.1)	75 (5.4)	17 (5.0)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on teachers' responses to four statements about types of interactions among advanced mathematics teachers: discussion about how to teach a particular concept, working on preparing instruction materials, visit to another teachers' classroom to observe his/her teaching, and informal observation of my classroom by another teacher. Responses

were provided on a 4-point Likert scale: 1) Never or almost never; 2) 2 or 3 times per month; 3) 1-3 times per week; 4) Daily or almost daily.

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

Exhibit 5.10 Schools' Reports on Ways They Evaluate Mathematics Teachers' Practices



Country	Percent of Students by Ways Their Schools Evaluate Mathematics Teachers' Practice			
	Observations by the Principal or Senior Staff	Observations by Inspectors or Other Persons External to the School	Student Achievement	Teacher Peer Review
Armenia	96 (0.4)	45 (0.7)	96 (0.1)	91 (0.4)
Iran, Islamic Rep. of	74 (4.5)	43 (5.2)	98 (1.4)	41 (5.1)
Italy	62 (6.4)	3 (1.8)	93 (3.1)	30 (5.9)
Lebanon	89 (1.9)	42 (2.4)	95 (1.0)	60 (2.4)
Netherlands	r 19 (5.2)	r 29 (5.2)	r 85 (3.5)	r 36 (5.7)
Norway	26 (4.7)	3 (2.1)	81 (5.5)	35 (6.4)
Philippines	99 (0.7)	68 (4.3)	97 (1.1)	83 (3.8)
Russian Federation	99 (0.9)	68 (4.0)	100 (0.0)	89 (2.6)
Slovenia	91 (2.4)	8 (2.4)	84 (3.3)	48 (5.9)
Sweden	58 (5.3)	11 (3.9)	90 (3.7)	44 (5.7)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by schools.

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

() Standard errors appear in parentheses.

Evaluation of teachers on the basis of their students' achievement is frequently portrayed, by teachers and others, as inherently unjust since it does not take into account differences in students' abilities, work habits, and the like. In spite of such opposition, for these teachers of advanced students, it was by far the most commonly used approach for teacher evaluation in these countries. Over 80 percent of students in every one of the participating countries were taught by teachers who were being evaluated, at least in part, on the basis of how well those students performed in advanced mathematics. The second most popular approach to teacher evaluation was classroom observations by the school principal or a senior staff member. Classroom observations by inspectors and peer reviews were less widely used. There appeared to be less emphasis given to teacher evaluation in the Netherlands and Norway than in the other participating countries, and much more in Armenia, the Philippines, and the Russian Federation.

Characteristics of Advanced Mathematics Classes

Exhibit 5.11 addresses the issue of class size and the relationship between class size and student achievement in advanced mathematics, using data supplied by the participating teachers about their TIMSS Advanced 2008 mathematics classes. The table first shows the average size of advanced mathematics classes in each country. The rest of the table is divided into four sections, one for each of four ranges of class size: viz., 1–24 students, 25–32 students, 33–40 students, and more than 40 students. For each of the four class-size categories, the table indicates the percentage of students in that country who were in an advanced mathematics class within that size range and the average TIMSS Advanced 2008 mathematics scale score for those students.

Only in the Philippines was the average class size greater than 30. In fact, the average was less than 25 in seven countries. The smallest

Exhibit 5.11 Achievement and Class Size for Advanced Mathematics Instruction

TIMSS Advanced 2008
Advanced Mathematics

Country	Overall Average Class Size	1–24 Students		25–32 Students		33–40 Students		41 or More Students	
		Percent of Students	Average Achievement						
Armenia	r 23 (0.3)	67 (3.2)	443 (7.3)	25 (3.1)	429 (13.0)	8 (0.3)	359 (26.6)	0 (0.0)	~ ~
Iran, Islamic Rep. of	30 (1.0)	28 (3.5)	482 (9.3)	41 (4.1)	506 (11.2)	12 (2.9)	496 (17.4)	19 (3.7)	504 (14.8)
Italy	21 (0.3)	80 (4.0)	444 (8.6)	20 (4.0)	465 (10.0)	0 (0.0)	~ ~	0 (0.0)	~ ~
Lebanon	18 (0.2)	78 (1.1)	548 (2.8)	15 (1.0)	533 (3.5)	4 (0.2)	540 (4.1)	4 (0.1)	540 (7.5)
Netherlands	17 (0.6)	82 (4.2)	555 (2.9)	16 (3.8)	547 (4.4)	2 (2.1)	~ ~	0 (0.0)	~ ~
Norway	21 (0.5)	70 (5.4)	437 (6.7)	30 (5.4)	443 (7.4)	0 (0.0)	~ ~	0 (0.0)	~ ~
Philippines	37 (0.7)	4 (1.1)	362 (33.8)	27 (4.1)	379 (11.9)	35 (4.3)	371 (11.4)	35 (5.1)	321 (10.7)
Russian Federation	23 (0.4)	58 (5.9)	565 (7.8)	42 (5.9)	555 (10.7)	0 (0.0)	~ ~	0 (0.0)	~ ~
Slovenia	28 (0.4)	17 (3.3)	400 (10.2)	73 (4.4)	469 (5.2)	11 (3.6)	473 (15.8)	0 (0.0)	~ ~
Sweden	24 (0.6)	46 (6.1)	405 (7.9)	51 (6.3)	420 (7.5)	2 (1.6)	~ ~	0 (0.0)	~ ~

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

A tilde (~) indicates insufficient data to report achievement.

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

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

Exhibit 5.12 Index of Student Factors Limiting Instruction in Advanced Mathematics

TIMSS Advanced 2008
Advanced Mathematics

Country	High (Few or No Limitations)		Medium (Some Limitations)		Low (Many Limitations)	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Norway	52 (5.2)	444 (5.4)	45 (4.9)	435 (8.0)	4 (2.3)	421 (48.6)
Netherlands	47 (4.6)	555 (3.5)	53 (4.6)	551 (3.5)	0 (0.0)	~ ~
Sweden	44 (5.5)	422 (6.8)	53 (5.6)	407 (7.5)	3 (1.4)	389 (17.2)
Armenia	r 35 (4.4)	441 (17.1)	56 (4.7)	426 (11.0)	9 (1.5)	444 (17.8)
Slovenia	34 (6.0)	484 (7.7)	64 (5.9)	445 (6.2)	2 (1.4)	~ ~
Lebanon	33 (2.3)	549 (4.0)	61 (2.4)	542 (2.9)	6 (1.0)	535 (9.4)
Russian Federation	32 (3.7)	585 (11.2)	56 (4.1)	549 (9.6)	12 (2.7)	552 (19.3)
Philippines	29 (4.7)	371 (9.4)	57 (4.7)	347 (9.1)	14 (3.1)	359 (14.1)
Italy	22 (5.5)	482 (12.6)	70 (5.5)	443 (9.0)	8 (2.8)	404 (17.8)
Iran, Islamic Rep. of	11 (2.4)	522 (18.9)	58 (3.8)	498 (8.0)	32 (3.8)	487 (10.1)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on teachers' responses to five statements about student factors limiting mathematics instruction: 1) Students with different academic abilities; 2) Students who come from a wide range of backgrounds; 3) Students with special needs; 4) Uninterested students; and 5) Disruptive students. Responses were provided on a 4-point scale: 1. Not at all; 2. A little; 3. Some; and 4. A lot. Students in the high category had teachers who reported few (if any) limitations, on average (less than 2), and those in the low category had teachers that reported their instruction was limited a lot, on average (greater than 3). The remaining students fell into the medium category.

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

A tilde (~) indicates insufficient data to report achievement.

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

average class size, 17 students, was found in the Netherlands. The finding of relatively small class sizes is further illustrated in the table by the low percentages of students registered in classes with 33 or more students. The results do not show any consistent relationship between class size and students' average achievement except perhaps in an association of higher achievement with smaller classes in Armenia and the Netherlands.

Many factors are known to present challenges to effective teaching, including the student composition of the classes. The teachers of advanced mathematics were asked to estimate to what extent five student-related factors limited their approaches to teaching. The five factors were: students with different academic abilities, students who came from a wide range of backgrounds, students with special needs, uninterested students, and disruptive students. Responses were given on a 4-point scale: *not at all*, *a little*, *some*, and *a lot*. TIMSS Advanced used the teachers' responses to construct an Index of Student Factors Limiting Instruction in Advanced Mathematics. Students were included in the high category if, on average, their teacher reported that there were few, if any, limitations of their instruction due to student factors. They were in the low category if, on average, teachers reported that student factors placed many limitations on their instruction. The remaining students constituted the medium category.

The results are presented in Exhibit 5.12. In the table, the countries are presented in descending order of the percentage of students in the high category. Considering that the students taking advanced mathematics are a select group and are in relatively small classes, it might be surprising that teachers said the composition of their classes did limit their teaching at least somewhat for substantial percentages of students. In general, students in the high category had higher achievement than students in the medium and low categories. However,

only in Norway were the slim majority of advanced mathematics students in classes in the high category where teachers reported that characteristics of the students presented few, if any limitations on their teaching. In the rest of the participating countries, the majority of students were in the medium category where teachers reported some limitations on average. In Iran, 32 percent of advanced mathematics students were taught by teachers who felt that the student factors presented many limitations on their instruction.

Activities in Advanced Mathematics Lessons

Exhibits 5.13 and 5.14 summarize the reports by students and by their teachers, respectively, about the frequency of occurrence of six instructional activities related to thinking skills covered in the TIMSS Advanced 2008 cognitive domains. The activities included memorizing formulas and procedures, solving problems like the ones in the student textbook, using mathematical terms to represent relationships, discussing problem-solving strategies, deciding which procedures to use in solving complex problems, and communicating arguments. Students were also asked about how frequently they watched the teacher demonstrate mathematics on a computer.

Exhibit 5.13 shows the percentages of students reporting that an activity occurred in at least half the lessons in their advanced mathematics class. The three activities identified by most students in nine countries as having occurred in at least half of their advanced mathematics classes were solving problems like the examples in their textbooks, using mathematical terminology to represent relationships, and discussing problem-solving strategies. The first and third of these activities are closely related and, taken together, likely indicate that working on mathematics problems in some fashion is a prevalent activity in advanced mathematics classes in these countries. In

Exhibit 5.13 **Students' Reports on Frequency of Various Learning Activities in Advanced Mathematics Lessons**

TIMSSAdvanced 2008
Advanced Mathematics

Country	Percent of Students Who Reported Doing the Activity in About Half the Lessons or More						
	Memorize Formulas and Procedures	Solve Problems Like the Examples in Our Textbook	Use Mathematical Terms to Represent Relationships	Discuss Problem-solving Strategies	Decide Procedures for Solving Complex Problems	Communicate Arguments	Watch the Teacher Demonstrate Mathematics on a Computer
Armenia	71 (1.8)	74 (1.8)	r 59 (2.0)	r 75 (2.1)	r 52 (2.5)	r 57 (2.3)	r 15 (1.8)
Iran, Islamic Rep. of	78 (1.3)	70 (1.2)	66 (1.3)	41 (1.3)	43 (1.5)	47 (1.3)	5 (0.9)
Italy	26 (1.2)	68 (2.2)	50 (1.6)	57 (1.9)	23 (1.6)	42 (2.4)	5 (0.8)
Lebanon	63 (1.4)	77 (1.2)	80 (0.9)	82 (1.1)	63 (1.2)	71 (1.2)	12 (1.0)
Netherlands	14 (1.4)	94 (0.7)	69 (1.5)	45 (2.2)	32 (1.7)	22 (1.5)	11 (2.2)
Norway	15 (1.0)	76 (1.4)	36 (1.5)	21 (1.1)	19 (1.0)	16 (1.1)	7 (1.6)
Philippines	78 (1.4)	76 (1.3)	82 (0.7)	85 (0.9)	47 (1.1)	58 (1.5)	7 (0.9)
Russian Federation	54 (1.7)	68 (1.9)	73 (1.3)	91 (0.9)	65 (1.5)	73 (1.2)	10 (1.2)
Slovenia	23 (1.2)	83 (1.3)	59 (1.6)	63 (1.6)	37 (1.9)	37 (1.8)	29 (1.4)
Sweden	82 (1.0)	84 (1.1)	69 (1.3)	43 (1.7)	39 (1.3)	23 (1.5)	6 (1.8)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by students.

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

() Standard errors appear in parentheses.

Exhibit 5.14 **Teachers' Reports on Frequency of Various Learning Activities in Advanced Mathematics Lessons**

TIMSSAdvanced 2008
Advanced Mathematics

Country	Percent of Students Whose Teachers Reported Students Doing the Activity in About Half the Lessons or More					
	Memorize Formulas and Procedures	Solve Problems Like the Examples in Their Textbooks	Use Mathematical Terms to Represent Relationships	Discuss Problem-solving Strategies	Decide Procedures for Solving Complex Problems	Communicate Arguments
Armenia	r 75 (4.2)	r 93 (1.4)	r 57 (3.1)	r 74 (3.3)	r 52 (3.0)	r 48 (4.4)
Iran, Islamic Rep. of	49 (4.0)	92 (2.4)	85 (2.9)	74 (3.5)	68 (3.8)	67 (3.8)
Italy	14 (3.2)	73 (5.0)	75 (4.0)	86 (3.4)	49 (6.4)	73 (3.6)
Lebanon	57 (2.1)	83 (2.2)	83 (1.8)	91 (0.9)	63 (2.3)	86 (1.6)
Netherlands	17 (5.1)	95 (2.3)	40 (5.8)	65 (4.4)	43 (4.4)	63 (4.5)
Norway	24 (5.9)	83 (3.9)	42 (4.9)	36 (4.9)	36 (4.8)	43 (5.0)
Philippines	39 (6.0)	62 (5.5)	76 (4.2)	78 (4.1)	68 (5.0)	73 (4.9)
Russian Federation	24 (3.3)	51 (3.4)	79 (3.9)	98 (1.6)	50 (6.3)	78 (4.6)
Slovenia	31 (5.7)	78 (4.3)	66 (5.7)	61 (5.4)	57 (6.9)	74 (5.2)
Sweden	17 (3.6)	70 (4.7)	71 (4.3)	65 (5.1)	50 (5.7)	45 (4.2)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

() Standard errors appear in parentheses.

Sweden, Iran, the Philippines, and Armenia, students also reported that memorizing formulas and procedures was a prevalent activity. Interestingly, according to Norwegian students, the only one of these activities that occurred in half or more of their advanced mathematics classes was solving problems similar to those in their textbooks. Watching the teacher demonstrate mathematics on a computer was selected by the smallest proportion of students in every country except Slovenia where it ranked second to last before memorizing rules and procedures.

Exhibit 5.14 shows the percentages of students whose teachers reported that an activity occurred in at least half the lessons. In agreement with the students, their teachers identified that the same three activities occurred with the largest percentages of students—solving problems like the examples in the textbooks, using mathematical terms to represent relationships, and discussing problem-solving strategies. Also, according to teachers' reports, memorizing formulas and procedures was not used nearly as extensively as reported by the students except in Armenia and Lebanon. In Sweden, the difference between teachers' and students' estimates was 65 percentage points: 83 percent for students and 18 for teachers. Iran, the Philippines, and the Russian Federation also had large differences on this point.

Exhibit 5.15 presents information about the use of textbooks in advanced mathematics classes in the participating countries. At least 83 percent of students in every country were taught by teachers who used one or more textbooks in their teaching. In fact, nearly all students (98 to 100%) were taught using a textbook in five countries: Armenia, Italy, the Netherlands, Norway, and Sweden. The table also shows that textbooks were authorized for use in the schools by a national authority in six countries, but this was not the case in the other four.

Exhibit 5.15 Policy and Usage of Textbooks

TIMSS Advanced 2008
Advanced Mathematics

Country	Textbooks Certified by National Authority	Percent of Students		Percent of Students Whose Teachers Require Them to Do the Following Activities in Half of the Lessons or More		
		Whose Teachers Use Textbooks for Teaching	Who Have Their Own Textbooks	Do Problems or Exercises from Their Textbooks	Read the Textbook Examples of How to Do Problems or Exercises	Read About Mathematical Theory from Their Textbooks
Armenia	●	r 100 (0.0)	r 95 (0.1)	r 95 (1.8)	r 71 (3.4)	r 65 (5.3)
Iran, Islamic Rep. of	●	96 (1.4)	98 (1.0)	96 (1.7)	92 (2.0)	81 (3.4)
Italy	○	98 (1.3)	94 (2.0)	96 (2.5)	58 (5.0)	55 (5.4)
Lebanon	●	87 (1.4)	89 (1.6)	91 (1.9)	69 (2.4)	69 (2.2)
Netherlands	○	100 (0.0)	100 (0.0)	98 (1.5)	66 (5.8)	56 (5.7)
Norway	○	100 (0.0)	100 (0.0)	99 (0.9)	64 (4.9)	53 (5.0)
Philippines	●	85 (3.3)	32 (4.1)	61 (6.2)	51 (6.2)	45 (5.5)
Russian Federation	●	83 (3.1)	97 (1.7)	86 (3.7)	40 (4.3)	41 (4.6)
Slovenia	●	94 (2.8)	91 (2.7)	68 (5.8)	28 (4.1)	16 (4.1)
Sweden	○	98 (1.8)	100 (0.0)	100 (0.4)	45 (5.5)	27 (4.7)

SOURCE: IEA TIMSS Advanced 2008 ©

● Yes ○ No

Data provided by National Research Coordinators and by teachers.

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

() Standard errors appear in parentheses.

The rightmost three data columns in the table provide information about how textbooks were used in advanced mathematics classrooms. Over 85 percent of students in eight of the participating countries—all but the Philippines and Slovenia—were taught by teachers who had them solve problems from the textbook. The other two alternatives for textbook use, reading examples of problem or exercise solutions provided in the textbook and reading about mathematical theory from the textbook, had much less support. Iran was the only country where more than 80 percent of the students had teachers who required these activities in at least half their advanced mathematics lessons.

The final exhibit in this section, Exhibit 5.16, focuses on the percentage of class time allocated by teachers of advanced mathematics to each of several activities. The activities listed were teaching new material to whole class, students working on problems or exercises either on their own or with other students, reviewing and summarizing what has been taught for the whole class, reviewing homework, reteaching and clarifying content or procedures for the whole class, oral or written tests or quizzes, classroom management tasks not related to the content or purpose of the lesson, and other activities. In responding to this item, teachers were asked to ensure that the total across all eight categories of activities came to 100 percent.

For students in every one of these countries, two activities—teaching new material to the class as a whole and students working on problems on their own or with other students—accounted for over 40 percent of the time in advanced mathematics classes. The whole class activities of reviewing what has been taught and reteaching or clarifying content and procedures each accounted for about 7 to 13 percent of the time, with reviewing homework accounting for as little as 5 percent of the time in Slovenia or Sweden to as much as 14 percent of the time in the Netherlands. The most variation across countries was

Exhibit 5.16 **Teachers' Reports of the Percent of Time in Mathematics Lessons Spent on Various Activities in a Typical Week**

TIMSS Advanced 2008
Advanced Mathematics

Country	Teaching New Material to the Whole Class	Students Working on Problems on Their Own or with Other Students	Reviewing and Summarizing What Has Been Taught for the Whole Class	Reviewing Homework
Armenia	r 27 (0.6)	r 23 (0.3)	r 10 (0.4)	r 7 (0.2)
Iran, Islamic Rep. of	43 (1.4)	15 (0.8)	8 (0.6)	7 (0.4)
Italy	27 (1.3)	13 (0.9)	11 (0.6)	13 (0.9)
Lebanon	23 (0.5)	22 (0.5)	11 (0.3)	10 (0.3)
Netherlands	21 (1.3)	43 (1.6)	8 (0.5)	14 (1.1)
Norway	28 (1.1)	39 (1.6)	8 (0.4)	9 (0.6)
Philippines	26 (1.3)	21 (0.9)	10 (0.6)	8 (0.4)
Russian Federation	23 (1.0)	29 (1.1)	12 (0.6)	8 (0.4)
Slovenia	37 (1.7)	18 (1.2)	13 (1.0)	5 (0.3)
Sweden	26 (0.6)	42 (1.1)	10 (0.6)	5 (0.4)

Country	Reteaching and Clarifying Content/Procedures for the Whole Class	Oral or Written Tests or Quizzes	Classroom Management Tasks not Related to the Lesson's Content/Purpose (e.g., Interruptions and Keeping Order)	Other Activities
Armenia	r 12 (0.5)	r 15 (0.4)	r 5 (0.2)	r 3 (0.1)
Iran, Islamic Rep. of	7 (0.4)	10 (0.5)	5 (0.4)	4 (0.3)
Italy	12 (0.7)	18 (0.9)	3 (0.4)	2 (0.5)
Lebanon	12 (0.3)	11 (0.3)	5 (0.2)	5 (0.2)
Netherlands	7 (0.4)	1 (0.3)	2 (0.3)	3 (0.7)
Norway	7 (0.8)	7 (0.5)	1 (0.3)	1 (0.2)
Philippines	10 (0.5)	16 (0.6)	5 (0.3)	4 (0.4)
Russian Federation	9 (0.4)	16 (0.7)	1 (0.1)	2 (0.3)
Slovenia	8 (0.8)	12 (0.6)	3 (0.3)	4 (0.4)
Sweden	9 (0.4)	6 (0.5)	2 (0.3)	1 (0.2)

Data provided by teachers.

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

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

SOURCE: IEA TIMSS Advanced 2008 ©

in the time devoted to tests or quizzes, ranging from only 1 percent in the Netherlands to 18 percent of the time in Italy. Very little time was taken up with classroom management tasks, at most 5 percent, and the “other” category also accounted for only a small proportion of time.

Technology Use in Advanced Mathematics Classes

Exhibit 5.17 focuses on the extent to which different technologies were used in advanced mathematics classes in the participating countries. The exhibit is divided into three parts: the first part dealing with calculators, the second with computers, and the third with other computing technology. Students were asked to indicate how frequently each of the three was used: in every or almost every lesson, in about half the lessons, in some lessons, or never. The table shows, for each country and for each frequency-of-usage category, the percent of students who chose that category and the average advanced mathematics achievement for those students.

In three countries—the Netherlands, Norway, and Sweden—most students (91 to 92%) said that they used calculators in every or almost every advanced mathematics class. In another three countries, about half (48 to 52%) the students said that they used calculators this frequently—Lebanon, the Philippines, and Slovenia. At the other extreme, significant proportions of students in Iran (30%) and the Russian Federation (24%) indicated that they never used calculators in their advanced mathematics classes.

In most countries, there was no obvious link between the extent of calculator use and students’ achievement. With few exceptions, the differences in average scale scores across usage categories were often small and the patterns across countries were inconsistent. In Slovenia, where calculators were used by all students at least in some lessons, there was an association between more frequent use of calculators and

Exhibit 5.17 **Students' Reports of Frequency of Using Different Technologies in Advanced Mathematics Lessons**

TIMSS Advanced 2008
Advanced Mathematics

Country	Frequency of Using Calculators							
	Every or Almost Every Lesson		About Half the Lessons		Some Lessons		Never	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	36 (2.3)	446 (8.3)	16 (1.9)	442 (14.6)	37 (2.2)	432 (7.2)	11 (1.2)	432 (13.3)
Iran, Islamic Rep. of	5 (0.6)	461 (11.8)	16 (1.2)	456 (7.2)	50 (1.2)	493 (5.9)	30 (1.6)	534 (8.6)
Italy	28 (2.0)	460 (8.0)	21 (1.1)	461 (8.3)	38 (1.5)	442 (8.5)	13 (1.2)	426 (11.7)
Lebanon	48 (1.5)	547 (2.6)	27 (1.1)	549 (4.5)	24 (1.2)	538 (4.8)	1 (0.3)	~ ~
Netherlands	92 (0.8)	553 (2.7)	6 (0.7)	557 (5.0)	2 (0.4)	~ ~	0 (0.1)	~ ~
Norway	92 (1.9)	442 (4.5)	4 (0.5)	393 (16.2)	2 (0.7)	~ ~	3 (1.1)	438 (22.2)
Philippines	49 (2.4)	350 (7.8)	27 (1.3)	356 (6.2)	23 (1.8)	360 (6.8)	1 (0.3)	~ ~
Russian Federation	22 (2.1)	549 (12.1)	16 (0.7)	555 (10.0)	38 (2.0)	562 (7.5)	24 (2.0)	574 (8.0)
Slovenia	52 (2.6)	474 (5.2)	32 (1.8)	449 (5.1)	15 (1.3)	427 (7.1)	1 (0.2)	~ ~
Sweden	91 (1.5)	416 (5.0)	5 (0.9)	412 (18.8)	2 (0.6)	~ ~	1 (0.3)	~ ~

SOURCE: IEA TIMSS Advanced 2008 ©

Country	Frequency of Using Computers							
	Every or Almost Every Lesson		About Half the Lessons		Some Lessons		Never	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	2 (0.7)	~ ~	2 (0.5)	~ ~	14 (1.6)	461 (15.0)	82 (1.9)	438 (5.3)
Iran, Islamic Rep. of	1 (0.3)	~ ~	2 (0.3)	~ ~	17 (1.0)	499 (10.1)	80 (1.2)	500 (6.2)
Italy	1 (0.2)	~ ~	2 (0.5)	~ ~	15 (1.9)	461 (13.8)	82 (2.1)	448 (7.4)
Lebanon	2 (0.4)	~ ~	4 (0.5)	506 (8.4)	19 (1.2)	547 (5.1)	74 (1.2)	549 (2.6)
Netherlands	1 (0.3)	~ ~	2 (0.7)	~ ~	30 (3.0)	554 (3.7)	67 (3.2)	553 (2.8)
Norway	7 (2.6)	450 (11.4)	2 (0.7)	~ ~	8 (1.6)	450 (11.9)	83 (3.5)	438 (4.9)
Philippines	1 (0.2)	~ ~	4 (0.6)	354 (17.8)	27 (1.6)	347 (8.2)	68 (1.9)	359 (5.6)
Russian Federation	1 (0.3)	~ ~	3 (0.4)	557 (14.0)	19 (2.1)	586 (11.5)	78 (2.4)	555 (6.7)
Slovenia	1 (0.6)	~ ~	4 (0.9)	443 (17.0)	28 (4.0)	462 (7.3)	66 (4.2)	457 (5.1)
Sweden	0 (0.1)	~ ~	0 (0.2)	~ ~	10 (1.7)	414 (11.9)	89 (1.7)	414 (5.4)

Data provided by students.

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

A dash (-) indicates comparable data are not available. A tilde (~) indicates insufficient data to report achievement.

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

Exhibit 5.17 **Students' Reports of Frequency of Using Different Technologies in Advanced Mathematics Lessons (Continued)**



Country	Frequency of Using Other Computing Technology								
	Every or Almost Every Lesson		About Half the Lessons		Some Lessons		Never		
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	
Armenia	r	2 (0.8)	~ ~	3 (0.8)	365 (30.2)	11 (1.6)	455 (17.9)	85 (2.3)	441 (5.0)
Iran, Islamic Rep. of		1 (0.2)	~ ~	2 (0.3)	~ ~	13 (0.9)	481 (10.3)	84 (1.0)	503 (6.1)
Italy		0 (0.1)	~ ~	1 (0.2)	~ ~	6 (0.9)	411 (14.9)	92 (1.0)	452 (7.2)
Lebanon		2 (0.4)	~ ~	4 (0.6)	512 (9.7)	15 (1.1)	535 (4.8)	79 (1.3)	551 (2.7)
Netherlands		3 (0.5)	545 (7.5)	2 (0.5)	~ ~	13 (1.0)	548 (4.7)	83 (1.3)	554 (2.8)
Norway		1 (0.4)	~ ~	0 (0.2)	~ ~	9 (1.0)	451 (9.4)	90 (1.1)	440 (4.9)
Philippines		1 (0.2)	~ ~	6 (0.5)	328 (8.9)	29 (1.2)	341 (6.8)	64 (1.5)	366 (5.6)
Russian Federation		3 (0.5)	531 (10.2)	4 (0.5)	555 (12.5)	18 (1.2)	568 (9.2)	75 (1.6)	561 (7.3)
Slovenia		2 (0.6)	~ ~	2 (0.5)	~ ~	14 (2.0)	461 (9.1)	82 (2.4)	457 (4.2)
Sweden		--	--	--	--	--	--	--	--

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by students.

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

A dash (-) indicates comparable data are not available. A tilde (~) indicates insufficient data to report achievement.

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

higher achievement. Students reporting calculator use in every lesson had the highest achievement, followed by those using calculators in half the lessons, and then, only some lessons. Interestingly, in the Russian Federation there were significant numbers of students in each of the four usage categories, with a slight category-by-category progression of higher achievement corresponding to less calculator use. Of the Iranian students, those who reported never using calculators in class had the highest average achievement.

The second part of Exhibit 5.17 deals with computer use in advanced mathematics classes, and the results show that computer use remains far from prevalent in these countries. At least two thirds of students from every participating country said that computers were never used in their advanced mathematics classes. Conversely, from 10 to 33 percent of students said that they used computers in at least some of their mathematics classes. This finding may have been anticipated since many of the topics in advanced mathematics courses at this level likely do not lend themselves well to the use of computers. Once again, most of the between-group differences in average achievement were small and did not consistently favor one group over the others.

The third part of Exhibit 5.17 concerns what was called “other computing technology” in the student questionnaire, and that term might not have been familiar to many students. In any case, the data show that such technologies are not in widespread use. Seventy-five percent or more of students in every country except the Philippines said that they never used other computing technology of any kind in their advanced mathematics classes.

Students were also asked to indicate what type of calculator they usually used, if they did use a calculator in their advanced mathematics class. Four types of calculators were listed and accompanied by brief descriptions, as follows:

- ▶ Simple calculator – basic functions only (+, −, ×, ÷, %, or $\sqrt{\quad}$), without functions like log, sin, cos
- ▶ Scientific calculator – basic functions (+, −, ×, ÷, %, or $\sqrt{\quad}$), and also functions like log, sin, cos
- ▶ Graphing calculator – scientific and also able to display some graphs
- ▶ Symbolic calculator – graphing and also able to solve expressions in symbolic terms

Exhibit 5.18 presents the percentage of students in each country who reported using each type of calculator. As discussed under 5.17 and reproduced here for reference (in the last data column), Iran and the Russian Federation were the only countries in which significant numbers of students reported that they never used calculators in advanced mathematics classes. Everywhere else, almost all students reported that they used some type of calculator in class. Norway (18%) and Sweden (11%) were the only countries in which appreciable numbers of students indicated that they used symbolic calculators. Most of the rest of students in Norway (76%) and Sweden (85%), as well as nearly all students in the Netherlands (95%), reported using a graphing calculator. Most students used a scientific calculator in Italy (79%), Lebanon (88%), the Philippines (95%), and Slovenia (93%).

Teachers were also asked about the kinds of calculators their students used during advanced mathematics classes, and their responses are presented in Exhibit 5.19. On the whole, teachers' responses about calculator use in their classes coincided with those of their students; however, there were a few differences, most no doubt stemming from a difference of opinion about what constituted, say, a symbolic calculator as opposed to a graphing calculator. For example, in Norway, both students and teachers agreed that there was an

Exhibit 5.18 Students' Reports on Types of Calculators Used During Advanced Mathematics Lessons

TIMSSAdvanced 2008
Advanced Mathematics

Country	Percent of Students Using				Percent of Students Who Never Used a Calculator
	Simple Calculator	Scientific Calculator	Graphing Calculator	Symbolic Calculator	
Armenia	60 (2.1)	26 (2.2)	1 (0.4)	2 (0.7)	11 (1.2)
Iran, Islamic Rep. of	41 (1.7)	27 (1.3)	1 (0.2)	1 (0.2)	30 (1.6)
Italy	5 (0.8)	79 (1.4)	2 (0.3)	1 (0.2)	13 (1.2)
Lebanon	5 (0.6)	88 (0.9)	3 (0.5)	3 (0.4)	1 (0.3)
Netherlands	0 (0.1)	0 (0.1)	95 (0.7)	5 (0.6)	0 (0.1)
Norway	0 (0.1)	3 (0.5)	76 (3.1)	18 (2.5)	3 (1.1)
Philippines	1 (0.2)	95 (1.3)	2 (1.2)	1 (0.2)	1 (0.3)
Russian Federation	33 (1.9)	42 (2.0)	1 (0.2)	0 (0.1)	24 (2.0)
Slovenia	4 (0.6)	93 (0.7)	1 (0.2)	1 (0.2)	1 (0.2)
Sweden	0 (0.1)	2 (0.5)	85 (1.5)	11 (1.4)	1 (0.3)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by students.

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

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

Exhibit 5.19 Teachers' Reports on the Types of Calculators Used by Students in the TIMSS Class During Advanced Mathematics Lessons

TIMSSAdvanced 2008
Advanced Mathematics

Country	Percent of Students Using				Percent of Students Who Never Used a Calculator
	Simple Calculator	Scientific Calculator	Graphing Calculator	Symbolic Calculator	
Armenia	62 (4.9)	29 (3.8)	3 (2.0)	1 (0.0)	5 (3.3)
Iran, Islamic Rep. of	37 (4.2)	35 (4.1)	0 (0.0)	0 (0.0)	28 (3.7)
Italy	3 (1.8)	91 (3.1)	6 (2.6)	0 (0.0)	0 (0.0)
Lebanon	6 (1.0)	87 (1.6)	3 (0.5)	3 (1.0)	1 (0.7)
Netherlands	0 (0.3)	0 (0.0)	99 (1.0)	1 (0.0)	0 (0.0)
Norway	2 (1.9)	0 (0.0)	92 (3.1)	5 (2.2)	1 (1.0)
Philippines	0 (0.0)	95 (2.0)	4 (1.8)	1 (0.6)	1 (0.0)
Russian Federation	30 (3.9)	57 (4.4)	0 (0.0)	0 (0.0)	13 (2.8)
Slovenia	10 (3.2)	90 (3.2)	0 (0.0)	0 (0.0)	0 (0.0)
Sweden	0 (0.0)	0 (0.1)	99 (0.8)	1 (0.6)	0 (0.0)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

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

extremely high usage of graphing or symbolic calculators, even though they differed as to how that total was partitioned between the two types. In Italy, though, there was a discrepancy in reports about use—teachers reported use for all students compared to 13 percent of the students reporting they never used calculators in their lessons.

Exhibit 5.20 presents data from teachers about the kinds of situations in which students were most likely to use calculators or computers in their advanced mathematics classes. The data are presented in terms of the percentage of students taught by teachers who estimated that their students used calculators or computers in a given situation in half of the lessons or more. The given situations were drawing graphs of functions, solving equations, modeling and simulation, numerical integration, and processing and analyzing data.

According to the teachers, calculators or computers were used in more classrooms and for more different activities in the Netherlands, Norway, and Sweden than they were elsewhere. In general, calculators or computers were reported to be used most heavily for drawing graphs of functions in the Netherlands, Norway, and Sweden and more generally across countries for solving equations. The least supported category across countries was using calculators or computers for modeling and simulation.

The last page of each TIMSS Advanced 2008 mathematics test booklet asked students to indicate whether or not they had used a calculator during the test, what type and brand of calculator they had used, and how extensively they had made use of it. They were given three choices for the last item: very little (for fewer than 5 questions), somewhat (for between 5 and 10 questions), and quite a lot (for more than 10 questions). The results are displayed in Exhibit 5.21, together with trend data on changes between the two cycles of TIMSS Advanced

Exhibit 5.20 **Teachers' Reports on Calculator or Computer Usage in Advanced Mathematics Class**

TIMSS Advanced 2008
Advanced Mathematics

Country	Percent of Students Whose Teachers Reported on Calculator or Computer Usage in About Half of the Lessons or More									
		Drawing Graphs of Functions		Solving Equations		Modeling and Simulation		Numerical Integration		Processing and Analyzing Data
Armenia	r	15 (4.3)	r	25 (3.0)	r	6 (0.3)	r	4 (0.2)	r	10 (0.3)
Iran, Islamic Rep. of		6 (2.1)		10 (1.9)		4 (1.7)		6 (2.1)		10 (2.7)
Italy		10 (3.3)		17 (4.3)		4 (2.4)		4 (2.1)		13 (3.6)
Lebanon	r	10 (1.7)	r	41 (2.8)	s	11 (2.4)	r	10 (1.5)	r	13 (2.1)
Netherlands		82 (4.1)		57 (5.8)		4 (1.9)		14 (3.5)		21 (4.6)
Norway		69 (3.9)		49 (5.5)		7 (2.9)		25 (4.3)		11 (3.6)
Philippines		9 (3.0)		47 (5.6)		11 (3.5)		19 (3.5)		24 (5.2)
Russian Federation		8 (2.5)		19 (3.4)		5 (1.9)		13 (2.8)		26 (3.6)
Slovenia		12 (4.2)		16 (4.3)		7 (3.5)		7 (2.8)		18 (4.0)
Sweden		88 (3.0)		42 (5.4)		23 (5.3)		46 (5.5)		48 (4.7)

SOURCE: IEA TIMSS Advanced 2008 ©

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

Exhibit 5.21 Trends in Students' Reports of Calculator Use During the TIMSS Advanced Mathematics Test



Country	Used Calculator Quite a Lot (More than 10 Questions)				Used Calculator Somewhat (5–10 Questions)			
	2008 Percent of Students	1995 Percent of Students	2008 Average Achievement	1995 Average Achievement	2008 Percent of Students	1995 Percent of Students	2008 Average Achievement	1995 Average Achievement
Armenia	3 (0.6)	◊ ◊	417 (23.3)	◊ ◊	10 (1.7)	◊ ◊	458 (18.2)	◊ ◊
Iran, Islamic Rep. of	0 (0.1)	◊ ◊	~ ~	◊ ◊	4 (0.5)	◊ ◊	442 (19.0)	◊ ◊
Italy	3 (0.4)	2 (0.5)	442 (16.5)	~ ~	17 (1.2)	13 (2.8)	449 (7.9) ▼	480 (10.8)
Lebanon	2 (0.4)	◊ ◊	~ ~	◊ ◊	20 (1.3)	◊ ◊	552 (4.3)	◊ ◊
Netherlands	34 (1.7)	◊ ◊	556 (3.5)	◊ ◊	45 (1.4)	◊ ◊	553 (2.9)	◊ ◊
Norway	19 (1.3)	◊ ◊	472 (5.9)	◊ ◊	43 (1.1)	◊ ◊	446 (5.1)	◊ ◊
Philippines	9 (0.7)	◊ ◊	349 (11.7)	◊ ◊	35 (1.6)	◊ ◊	359 (7.4)	◊ ◊
Russian Federation	1 (0.2)	1 (0.3)	~ ~	~ ~	13 (0.7) ▲	8 (1.0)	558 (9.8) ▲	522 (10.9)
Slovenia	6 (1.0) ▲	1 (0.4)	479 (11.6)	~ ~	31 (1.5) ▲	10 (1.3)	468 (5.1)	483 (13.3)
Sweden	16 (1.1) ▲	11 (1.2)	455 (7.6) ▼	513 (11.9)	34 (1.4) ▼	46 (2.1)	437 (4.7) ▼	508 (4.3)

SOURCE: IEA TIMSS Advanced 2008 ©

Country	Used Calculator Very Little (Less than 5 Questions)				Did Not Use a Calculator			
	2008 Percent of Students	1995 Percent of Students	2008 Average Achievement	1995 Average Achievement	2008 Percent of Students	1995 Percent of Students	2008 Average Achievement	1995 Average Achievement
Armenia	25 (1.6)	◊ ◊	477 (8.3)	◊ ◊	63 (2.2)	◊ ◊	420 (5.9)	◊ ◊
Iran, Islamic Rep. of	31 (1.8)	◊ ◊	499 (8.7)	◊ ◊	65 (1.9)	◊ ◊	503 (6.9)	◊ ◊
Italy	50 (1.8)	47 (3.6)	458 (7.9) ▼	496 (10.4)	31 (1.9)	38 (5.1)	434 (10.4)	472 (19.9)
Lebanon	58 (1.5)	◊ ◊	550 (2.9)	◊ ◊	20 (1.4)	◊ ◊	540 (4.6)	◊ ◊
Netherlands	20 (1.3)	◊ ◊	554 (3.3)	◊ ◊	1 (0.4)	◊ ◊	~ ~	◊ ◊
Norway	34 (1.3)	◊ ◊	422 (5.7)	◊ ◊	5 (0.5)	◊ ◊	379 (15.0)	◊ ◊
Philippines	41 (1.5)	◊ ◊	362 (4.8)	◊ ◊	15 (1.9)	◊ ◊	331 (12.1)	◊ ◊
Russian Federation	54 (1.3) ▲	41 (2.0)	565 (7.2)	558 (8.8)	32 (1.5) ▼	50 (2.4)	555 (8.4)	557 (9.5)
Slovenia	46 (1.3) ▼	64 (2.4)	466 (4.8) ▼	494 (9.8)	16 (1.6) ▼	26 (2.4)	416 (6.5)	438 (10.9)
Sweden	38 (1.2)	39 (2.0)	396 (7.2) ▼	497 (9.1)	11 (1.5) ▲	3 (0.7)	339 (10.4) ▼	468 (25.1)

- ▲ 2008 significantly higher than 1995
- ▼ 2008 significantly lower than 1995

Data provided by students.

Depending on the booklet assigned, students responded to 36–38 mathematics items. Items were designed to be answered without a calculator, and students were asked to show their work for constructed-response items. However, about half the items could be answered using a graphing or symbolic calculator.

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

A diamond (◊) indicates the country did not participate in the 1995 assessment.

A tilde (~) indicates insufficient data to report achievement.

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.

for the four countries that participated in both 1995 and 2008: Italy, the Russian Federation, Slovenia, and Sweden.

As would be anticipated based on the heavy use of calculators in their instruction, the most use of calculators on the TIMSS Advanced 2008 mathematics test was reported by students in the Netherlands, Norway, and Sweden. Slightly more than a third of Dutch students said they had used their calculators on at least 10 of the test items, and between 15 and 20 percent of Norwegian and Swedish students said the same. In five of the seven other countries—Armenia, Iran, Italy, Lebanon, and the Russian Federation—more than three fourths of students said that they had either not used their calculators on the test at all, or had used them on fewer than five items.

In the four countries that participated in both cycles of the study—Italy, the Russian Federation, Slovenia, and Sweden—the trend data showed increases in the proportions of students using calculators in 2008 compared to 1995 in the Russian Federation and Slovenia. The Slovenian students moved into the higher use categories and those in the Russian Federation moved into the middle use categories. There was essentially no change in use for Italian students. Interestingly, in Sweden the percentage of students in the “somewhat” category decreased while the percentages increased in the two extremes of using the calculator “quite a lot” or “very little.” The students’ average achievement associated with the usage categories basically reflects students’ overall patterns and changes between the two assessment cycles.

The Role of Homework in Advanced Mathematics Instruction

Exhibit 5.22 contains teachers’ reports about their emphasis on homework. For the Index of Teachers’ Emphasis on Mathematics Homework, students in the high category had teachers who reported

Exhibit 5.22 **Index of Teachers' Emphasis on Advanced Mathematics Homework (EMH)**



Country	High EMH		Medium EMH		Low EMH	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Russian Federation	95 (2.2)	559 (7.3)	5 (2.2)	587 (19.4)	0 (0.0)	~ ~
Italy	88 (3.5)	454 (7.3)	11 (3.3)	425 (22.5)	1 (1.1)	~ ~
Lebanon	83 (1.8)	546 (2.5)	10 (1.4)	528 (4.5)	7 (1.2)	552 (14.9)
Armenia	82 (0.7)	428 (6.0)	13 (0.6)	466 (6.8)	4 (0.2)	434 (15.3)
Iran, Islamic Rep. of	79 (3.0)	502 (7.5)	10 (2.0)	481 (12.6)	12 (2.3)	473 (16.2)
Norway	70 (4.0)	440 (5.7)	16 (4.2)	442 (12.0)	14 (2.4)	430 (9.7)
Netherlands	53 (5.5)	553 (3.4)	27 (5.3)	552 (4.4)	20 (4.1)	552 (6.5)
Slovenia	47 (5.6)	467 (7.3)	46 (5.7)	453 (9.3)	7 (3.0)	435 (13.3)
Sweden	39 (4.8)	426 (7.1)	23 (4.5)	419 (10.3)	38 (5.7)	397 (8.8)
Philippines	34 (4.5)	383 (10.2)	53 (4.7)	343 (9.1)	13 (2.6)	329 (17.5)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on teachers' responses to three questions about whether they assign mathematics homework, how often they usually assign mathematics homework and how many minutes of mathematics homework they usually assign. Students in the high category were assigned more than 30 minutes of homework about half of the lessons or more, and those in low category were assigned less than 30 minutes of homework about half of the lessons or less. The medium category includes all other possible combinations of responses.

() Standard errors appear in parentheses. Because results are rounded to the nearest whole number, some totals may appear inconsistent.
 A tilde (~) indicates insufficient data to report achievement.

giving relatively long homework assignments (more than 30 minutes) on a relatively frequent basis (in about half the lessons or more). Students in the low category had teachers who gave short assignments (less than 30 minutes) relatively infrequently (in about half the lessons or less). The medium level includes all other possible combinations of teachers' responses. The exhibit shows, for each country, the percentage of students in each category together with their average TIMSS Advanced 2008 mathematics scale score. The countries are listed in descending order of the proportion of students in the high category.

Nearly all students in the Russian Federation were in the high category (95%), followed by Italy (88%). Approximately 80 percent of the students were in the high category in Lebanon, Armenia, and Iran. With 38 percent, Sweden had the most students whose teachers assigned very little, if any homework (i.e., they assigned 30 minutes or less of homework in no more than half their lessons). The Netherlands also had 20 percent of its students in this category. Teachers in the other countries responded such that 86 percent or more of their students were in either the high or medium group. The data concerning a relationship between amount of homework assigned and students' achievement differed across countries. In half of the countries, there was a positive relationship between the amount of homework assigned and students' achievement (Italy, Iran, Slovenia, Sweden, and the Philippines). Interestingly, in Norway and the Netherlands average achievement was essentially the same across the high, medium, and low homework classifications.

Teachers were also asked about how frequently they included, as part of a homework assignment for their students, each of five activities: doing problem/question sets; reading the textbook; memorizing formulas and procedures; gathering, analyzing, and reporting data; and finding one or more applications of the content covered. The results are presented in Exhibit 5.23 in terms of the percentage of students in

Exhibit 5.23 **Teachers’ Reports on the Kinds of Mathematics Homework Assigned to the TIMSS Advanced Mathematics Class**



Country	Percent of Students by Types of Homework Assigned by Their Teachers								
	Doing Problem/Question Sets			Reading the Textbook			Memorizing Formulas and Procedures		
	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never
Armenia	r 89 (2.4)	11 (2.4)	0 (0.0)	r 50 (6.3)	40 (6.1)	9 (1.6)	r 70 (5.3)	19 (5.2)	11 (0.5)
Iran, Islamic Rep. of	70 (3.8)	29 (3.7)	1 (0.7)	50 (4.1)	46 (4.3)	3 (1.5)	33 (4.5)	50 (4.6)	16 (2.6)
Italy	93 (3.6)	6 (2.9)	2 (1.3)	36 (5.1)	50 (5.5)	15 (4.0)	10 (3.2)	56 (5.6)	34 (4.8)
Lebanon	83 (1.6)	16 (1.6)	1 (0.1)	37 (2.2)	55 (2.6)	8 (1.8)	37 (2.4)	51 (2.3)	12 (1.2)
Netherlands	100 (0.0)	0 (0.0)	0 (0.0)	22 (5.8)	42 (5.7)	36 (6.0)	0 (0.0)	48 (6.0)	52 (6.0)
Norway	87 (3.3)	13 (3.3)	0 (0.0)	32 (4.1)	52 (4.5)	17 (3.7)	10 (5.1)	46 (5.9)	44 (5.0)
Philippines	62 (5.7)	38 (5.7)	0 (0.0)	15 (3.5)	68 (4.2)	17 (3.7)	30 (5.2)	57 (5.2)	13 (3.6)
Russian Federation	97 (1.7)	3 (1.7)	0 (0.0)	46 (4.4)	46 (4.8)	8 (2.7)	39 (3.9)	53 (4.3)	8 (2.5)
Slovenia	95 (3.3)	5 (3.3)	0 (0.0)	0 (0.0)	38 (6.2)	62 (6.2)	5 (1.6)	43 (7.3)	52 (7.3)
Sweden	87 (3.5)	11 (3.9)	2 (1.6)	17 (3.9)	52 (5.8)	31 (5.6)	1 (0.8)	34 (6.5)	66 (6.4)

SOURCE: IEA TIMSS Advanced 2008 ©

Country	Percent of Students by Types of Homework Assigned by Their Teachers					
	Gathering, Analyzing, and Reporting Data			Finding One or More Applications of the Content Covered		
	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never
Armenia	r 33 (4.3)	52 (4.0)	15 (2.3)	r 10 (2.6)	69 (3.8)	21 (2.9)
Iran, Islamic Rep. of	31 (4.2)	58 (4.6)	11 (2.1)	18 (3.2)	64 (4.2)	18 (3.0)
Italy	4 (2.1)	43 (5.1)	52 (5.1)	22 (3.9)	56 (6.3)	23 (5.1)
Lebanon	36 (3.0)	50 (2.9)	15 (1.5)	27 (2.2)	61 (2.3)	12 (1.2)
Netherlands	1 (0.1)	21 (5.2)	78 (5.3)	2 (1.2)	13 (4.3)	86 (4.4)
Norway	0 (0.0)	18 (3.9)	82 (3.9)	0 (0.0)	30 (5.0)	70 (5.0)
Philippines	13 (3.1)	65 (4.9)	21 (4.4)	18 (3.8)	75 (4.3)	8 (2.8)
Russian Federation	18 (3.5)	69 (3.9)	13 (2.9)	33 (4.4)	63 (4.0)	4 (1.9)
Slovenia	0 (0.0)	43 (5.6)	57 (5.6)	0 (0.0)	32 (5.5)	68 (5.5)
Sweden	0 (0.0)	28 (4.5)	72 (4.5)	0 (0.0)	36 (5.6)	64 (5.6)

Data provided by teachers.

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

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

each country whose teachers indicated that they assigned a particular activity *always or almost always, sometimes, or never or almost never*.

The most popular kind of homework assignment in every one of these countries was “doing problem/question sets.” Virtually 100 percent of the students in every country were asked to complete such an assignment for homework at least sometimes and in many countries the majority of students were asked to do so always or almost always. Reading from the textbook and memorizing formulas and procedures were also assigned at least sometimes for a clear majority of students in a number of the countries. Except that these activities were used less frequently, in general, cross-national patterns varied with respect to the other two activities: data analysis and finding applications of recently covered content.

Students were asked about how much homework they did, and how frequently that homework involved three of the five activities that teachers had also been asked about: doing problem/question sets, reading the textbook, and memorizing formulas and procedures. Their responses are summarized in Exhibit 5.24. For each country, the exhibit indicates the average number of hours per week that the students spent on mathematics homework as well as the percentage of students who reported that they “always or almost always”, “sometimes”, or “never or almost never” had homework that involved each of those activities.

Students’ reports tended to correspond with the reports of their teachers—that is, students appear to be doing the assigned homework. Students in the Netherlands, Norway, and Sweden recorded the lowest average number of hours per week spent on mathematics homework: less than two hours in total. Students in Lebanon and the Russian Federation reported spending about three times as much time on mathematics homework: about six hours

Exhibit 5.24 **Students' Reports on the Time Spent Doing Various Kinds of Mathematics Homework**



Country	Average Hours per Week Spent Doing Mathematics Homework	Percent of Students Doing Various Activities for Mathematics Homework								
		Problem/Question Sets			Read the Textbook			Memorize Formulas and Procedures		
		Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never
Armenia	r 4.3 (0.15)	r 54 (2.1)	42 (2.0)	4 (0.9)	r 31 (2.0)	57 (2.1)	11 (1.2)	r 51 (2.4)	43 (2.2)	6 (1.0)
Iran, Islamic Rep. of	r 5.3 (0.11)	49 (1.5)	49 (1.5)	2 (0.4)	45 (1.6)	46 (1.5)	9 (0.8)	45 (1.4)	51 (1.3)	5 (0.6)
Italy	2.8 (0.11)	44 (2.1)	42 (1.6)	14 (1.3)	15 (1.5)	53 (1.3)	32 (1.7)	29 (1.9)	54 (1.7)	17 (1.4)
Lebanon	5.9 (0.10)	62 (1.5)	36 (1.5)	2 (0.3)	25 (1.0)	62 (1.3)	13 (1.0)	38 (1.2)	48 (1.3)	13 (0.9)
Netherlands	1.7 (0.07)	75 (1.2)	21 (1.2)	4 (0.6)	21 (1.4)	58 (1.7)	21 (2.0)	3 (0.5)	36 (2.1)	61 (1.9)
Norway	1.7 (0.05)	87 (0.9)	12 (0.8)	1 (0.3)	32 (1.8)	56 (1.5)	12 (1.5)	4 (0.5)	38 (1.7)	58 (1.6)
Philippines	3.1 (0.08)	49 (1.0)	49 (1.0)	1 (0.2)	15 (1.3)	68 (1.1)	17 (1.6)	44 (2.0)	53 (1.9)	3 (0.4)
Russian Federation	6.0 (0.17)	80 (1.1)	19 (1.0)	1 (0.2)	15 (1.2)	65 (1.2)	20 (1.3)	54 (1.5)	42 (1.3)	3 (0.5)
Slovenia	r 2.0 (0.12)	72 (2.5)	25 (2.2)	3 (0.6)	r 3 (0.4)	30 (2.3)	67 (2.3)	8 (1.0)	56 (2.2)	37 (2.2)
Sweden	s 1.1 (0.06)	r 77 (1.3)	22 (1.2)	2 (0.4)	r 45 (1.6)	48 (1.5)	7 (0.8)	r 16 (1.1)	58 (1.7)	26 (1.9)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

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.

a week. Students in Iran also reported relatively heavy homework schedules of about five hours per week. According to over 85 percent of students in each of the participating countries, their mathematics homework at least sometimes included doing problem/question sets. The lowest levels of homework activity were reported for reading the textbook in Slovenia and for memorizing formulas and procedures in the Netherlands and Norway. Apart from these three exceptions, a majority of students in every country reported that their mathematics homework included one or more of these three activities at least sometimes.

Types of Assessments Used in Advanced Mathematics Classes

This section concerns the assessment practices used by teachers of advanced mathematics in the participating countries to monitor their students' progress. Teachers were asked about the degree of emphasis they assigned to each of three possible data sources: classroom tests (e.g., teacher-made or textbook tests), informal assessment, and other tests. For each source, teachers indicated whether it was given major emphasis, some emphasis, or little or no emphasis. Results are presented in Exhibit 5.25 in terms of the percentage of students who were taught by teachers who reported that a given data source was accorded major, some, or little emphasis in their evaluation procedures.

Teachers in all the participating countries said that they placed much more emphasis on classroom tests (e.g., teacher-made or textbook tests) as sources of data on student progress than on either of the two other alternatives. Ninety-six percent or more of students in every one of these 10 countries were taught by teachers who indicated that they placed either major or some emphasis on such tests. The two other forms of assessment—informal assessment and other tests—were used by many teachers, but less emphasis was given to them.

Exhibit 5.25 **Teachers’ Emphasis on Sources to Monitor Students’ Progress in Mathematics**

TIMSS Advanced 2008
Advanced Mathematics

Country	Percent of Students by Their Teachers' Emphasis on Various Sources to Monitor Students' Progress								
	Classroom Tests (e.g., Teacher-made or Textbook Tests)			Informal Assessment			Other Tests		
	Major Emphasis	Some Emphasis	Little or No Emphasis	Major Emphasis	Some Emphasis	Little or No Emphasis	Major Emphasis	Some Emphasis	Little or No Emphasis
Armenia	67 (4.2)	29 (4.2)	4 (0.2)	6 (3.1)	42 (4.7)	52 (5.8)	44 (5.0)	35 (4.6)	21 (2.1)
Iran, Islamic Rep. of	62 (4.5)	35 (4.3)	3 (1.2)	20 (3.4)	49 (4.1)	31 (3.7)	17 (3.4)	44 (4.3)	38 (3.9)
Italy	71 (5.0)	29 (5.0)	0 (0.0)	18 (4.0)	60 (5.4)	23 (4.6)	17 (3.5)	51 (5.1)	33 (5.5)
Lebanon	72 (2.4)	23 (2.3)	4 (1.1)	r 39 (2.6)	37 (2.3)	24 (2.2)	r 24 (2.5)	43 (2.8)	33 (2.9)
Netherlands	96 (1.8)	2 (1.4)	1 (1.1)	5 (1.8)	16 (3.9)	78 (4.3)	--	--	--
Norway	96 (1.7)	4 (1.7)	0 (0.0)	6 (1.8)	65 (4.4)	29 (4.7)	--	--	--
Philippines	87 (3.4)	12 (3.3)	1 (0.0)	45 (5.5)	50 (6.0)	6 (2.4)	r 15 (3.7)	54 (5.6)	31 (4.5)
Russian Federation	95 (2.0)	4 (1.8)	1 (0.9)	20 (3.8)	55 (5.0)	25 (3.7)	12 (3.2)	51 (4.6)	37 (3.6)
Slovenia	75 (5.2)	23 (4.9)	2 (1.7)	51 (6.0)	43 (6.0)	6 (2.5)	18 (4.8)	55 (5.1)	27 (4.9)
Sweden	76 (3.8)	23 (3.8)	1 (0.5)	28 (4.0)	59 (5.0)	12 (3.7)	74 (4.1)	25 (3.9)	1 (0.0)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

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

A dash (–) indicates comparable data are not available.

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

In most participating countries, significant proportions of students were taught by teachers who gave little or no emphasis to either of these alternatives.

Exhibit 5.26 provides information about how often teachers administered tests or examinations to their TIMSS Advanced 2008 mathematics classes. Teachers were asked to select one of four alternatives: at least once a month, about every other month, about 2 or 3 times a year, and never. For each of these four groups, the results in Exhibit 5.26 show the percentage of students taught by teachers in that category and the average mathematics achievement for those students.

All students of advanced mathematics in these countries were taught by teachers who gave tests or examinations at least several times during the year. In every country except the Netherlands, at least three fourths of students (much more than three fourths in most cases) were administered a test or examination at least every other month. In Italy, the Philippines, and the Russian Federation, three fourths or more of the students were tested at least monthly. With the possible exception of Armenia, the direction of the achievement differences in a given country across the four groups of students did not favor one group over the others in a consistent fashion.

Exhibit 5.27 provides information about the item formats advanced mathematics students in these countries were most likely to see on tests and examinations. Teachers were asked to report whether the tests and examinations they administered to their students consisted of constructed-response items only, mostly constructed-response items, about half constructed-response and half objective items, mostly objective items, or only objective items. For each of these five groups, the results in Exhibit 5.27 show the percentages of students whose teachers used the various formats and the average achievement of those students.

Exhibit 5.26 Frequency of Advanced Mathematics Tests

TIMSSAdvanced2008
Advanced Mathematics

Country	Percent of Students Whose Teachers Give a Mathematics Test or Examination							
	At Least Once a Month		About Every Other Month		About 2 or 3 Times a Year		Never	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	r 42 (3.5)	453 (10.0)	r 34 (1.9)	432 (5.1)	r 24 (2.9)	396 (14.9)	r 0 (0.1)	~ ~
Iran, Islamic Rep. of	43 (4.1)	505 (10.3)	34 (4.0)	485 (8.9)	23 (2.9)	500 (12.6)	0 (0.0)	~ ~
Italy	85 (3.5)	452 (7.8)	11 (3.1)	423 (31.4)	5 (1.9)	434 (15.1)	0 (0.0)	~ ~
Lebanon	71 (2.1)	544 (3.0)	25 (2.0)	545 (3.9)	5 (0.6)	545 (6.0)	0 (0.0)	~ ~
Netherlands	5 (2.2)	543 (8.5)	59 (5.2)	553 (3.3)	36 (5.3)	553 (3.9)	0 (0.0)	~ ~
Norway	33 (5.6)	434 (7.8)	67 (5.6)	442 (6.0)	0 (0.0)	~ ~	0 (0.0)	~ ~
Philippines	75 (4.3)	363 (7.4)	21 (4.2)	331 (13.1)	4 (1.5)	360 (39.3)	0 (0.0)	~ ~
Russian Federation	93 (2.0)	560 (8.1)	7 (2.0)	578 (18.1)	0 (0.0)	~ ~	0 (0.0)	~ ~
Slovenia	29 (5.1)	456 (11.2)	70 (5.2)	460 (4.7)	1 (0.9)	~ ~	0 (0.0)	~ ~
Sweden	15 (4.4)	424 (10.2)	68 (5.4)	406 (7.0)	17 (3.9)	431 (12.4)	0 (0.0)	~ ~

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

A tilde (~) indicates insufficient data to report achievement.

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

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

Exhibit 5.27 Formats of Questions Used by Teachers in Advanced Mathematics Tests or Examinations

TIMSSAdvanced2008
Advanced Mathematics

Country	Only Constructed-response		Mostly Constructed-response		About Half Constructed-response and Half Objective (e.g., Multiple-choice)		Mostly Objective		Only Objective	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	8 (1.9)	422 (15.0)	4 (0.1)	443 (33.4)	59 (4.7)	435 (8.5)	26 (4.6)	452 (16.2)	3 (0.1)	396 (20.3)
Iran, Islamic Rep. of	10 (2.4)	464 (10.9)	33 (4.2)	488 (9.4)	48 (4.5)	506 (10.4)	8 (2.3)	507 (25.9)	0 (0.0)	~ ~
Italy	31 (4.6)	474 (10.3)	48 (6.2)	456 (10.7)	14 (3.7)	398 (20.7)	6 (2.3)	374 (12.5)	1 (0.8)	~ ~
Lebanon	5 (1.0)	556 (9.1)	35 (2.3)	551 (4.6)	25 (2.0)	546 (4.2)	31 (1.8)	533 (3.5)	4 (0.8)	547 (5.0)
Netherlands	94 (2.4)	553 (2.7)	2 (1.3)	~ ~	2 (1.2)	~ ~	2 (1.6)	~ ~	0 (0.0)	~ ~
Norway	19 (4.4)	438 (9.7)	47 (5.3)	438 (6.9)	20 (3.8)	444 (12.5)	10 (3.4)	429 (12.4)	3 (1.8)	435 (25.6)
Philippines	0 (0.0)	~ ~	27 (5.6)	354 (13.5)	66 (5.0)	356 (7.9)	5 (1.5)	381 (33.3)	1 (1.5)	~ ~
Russian Federation	23 (3.7)	568 (10.4)	43 (4.0)	571 (8.5)	34 (4.5)	543 (14.3)	0 (0.0)	~ ~	0 (0.0)	~ ~
Slovenia	58 (6.2)	475 (6.2)	38 (6.3)	436 (9.5)	4 (2.1)	396 (25.8)	0 (0.0)	~ ~	1 (0.8)	~ ~
Sweden	56 (4.7)	417 (7.5)	43 (4.7)	407 (7.4)	1 (0.7)	~ ~	0 (0.0)	~ ~	0 (0.0)	~ ~

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by teachers.

A tilde (~) indicates insufficient data to report achievement.

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

There was substantial variation across countries in testing approaches. In the Netherlands, almost 95 percent of students were taught by teachers whose tests consisted exclusively of constructed-response items, the only country where that was the case. Slovenia and Sweden also reported extensive use of constructed-response items, exclusively for the majority of students and mostly for nearly all the rest of the students. Mostly constructed-response tests or tests that included both constructed-response and objective items were used for two thirds or more of students in Iran, Lebanon, Norway, the Philippines, and the Russian Federation. The most use of objective items (e.g., multiple-choice items) was reported in Armenia and Lebanon where over a quarter of students were taught by teachers whose tests were mostly objective. In the other countries, less than 10 percent of students were in that category. Once again, between-group, within-country differences in achievement did not favor one group over the others in a consistent fashion.

The focus of Exhibit 5.28 is the level of cognitive demand teachers emphasized in the mathematics tests they administered to their TIMSS Advanced 2008 students. Teachers were asked to indicate the frequency (always or almost always, sometimes, never or almost never) with which they included items requiring each of four levels of cognitive demand (recall of facts and procedures, application of mathematical procedures, searching for patterns and relationships, and explanations or justifications) on their tests. For each of these four cognitive-demand categories, the results in Exhibit 5.28 show the percentage of students who were taught by teachers in that category.

At least 97 percent of students in every country were taught by teachers who said that the tests they administered to their advanced mathematics students at least sometimes included items that required students to apply mathematical procedures. At least 94 percent of

Exhibit 5.28 **Types of Questions in Advanced Mathematics Tests**

TIMSS Advanced 2008
Advanced Mathematics

Country	Percent of Students by Types of Questions Teachers Include in Their Mathematics Tests								
	Questions Based Primarily on Recall of Facts and Procedures			Questions Involving Application of Mathematical Procedures			Questions Involving Searching for Patterns and Relationships		
	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never	Always or Almost Always	Sometimes	Never or Almost Never
Armenia	53 (2.9)	47 (2.9)	0 (0.0)	82 (3.3)	15 (3.3)	3 (0.2)	24 (4.0)	73 (4.0)	3 (0.1)
Iran, Islamic Rep. of	60 (4.0)	39 (3.9)	1 (0.9)	57 (3.7)	42 (3.6)	1 (0.7)	34 (4.0)	63 (4.2)	3 (1.1)
Italy	23 (5.0)	57 (4.8)	19 (4.1)	85 (4.0)	15 (4.0)	0 (0.0)	21 (5.3)	62 (5.2)	17 (3.5)
Lebanon	26 (2.2)	58 (2.5)	15 (1.7)	67 (2.6)	32 (2.6)	1 (0.5)	45 (2.6)	54 (2.6)	1 (0.5)
Netherlands	26 (4.8)	21 (4.7)	53 (5.6)	86 (4.3)	13 (4.2)	1 (0.7)	39 (5.3)	52 (5.7)	9 (3.3)
Norway	50 (5.0)	42 (5.3)	8 (2.8)	77 (4.1)	23 (4.1)	0 (0.0)	25 (3.7)	62 (4.1)	12 (2.2)
Philippines	28 (4.9)	67 (5.0)	5 (1.9)	91 (2.9)	8 (2.7)	1 (0.0)	38 (4.3)	58 (4.3)	4 (1.9)
Russian Federation	42 (3.9)	51 (4.6)	8 (2.4)	86 (2.9)	14 (2.9)	0 (0.0)	39 (3.9)	58 (4.2)	4 (1.9)
Slovenia	85 (4.3)	15 (4.3)	0 (0.0)	92 (3.2)	8 (3.2)	0 (0.0)	40 (6.0)	56 (6.2)	3 (1.9)
Sweden	17 (4.2)	32 (4.4)	52 (5.0)	83 (4.0)	17 (4.0)	0 (0.0)	14 (3.4)	73 (4.2)	12 (3.0)

SOURCE: IEA TIMSS Advanced 2008 ©

Country	Percent of Students by Types of Questions Teachers Include in Their Mathematics Tests (Continued)		
	Questions Requiring Explanations or Justifications		
	Always or Almost Always	Sometimes	Never or Almost Never
Armenia	74 (4.8)	23 (4.8)	3 (0.2)
Iran, Islamic Rep. of	33 (4.0)	61 (4.0)	5 (1.5)
Italy	58 (4.7)	42 (4.7)	0 (0.0)
Lebanon	75 (2.2)	24 (2.2)	1 (0.4)
Netherlands	44 (4.7)	55 (4.7)	0 (0.0)
Norway	48 (4.8)	45 (4.3)	6 (3.0)
Philippines	30 (4.9)	66 (5.1)	4 (1.8)
Russian Federation	87 (3.2)	11 (3.0)	2 (1.6)
Slovenia	8 (2.8)	68 (5.5)	25 (4.6)
Sweden	85 (3.6)	15 (3.6)	0 (0.0)

Data provided by teachers.

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

students in every country except Slovenia were taught by teachers who at least sometimes included items requiring explanations or justifications on their tests. Eighty-three percent or more of students were taught by teachers whose tests at least sometimes included items calling for students to investigate mathematical patterns and relationships. The largest differences occurred in asking students to recall facts or procedures. In the Netherlands and Sweden, half the students (51–53%) were never asked these types of questions on tests, and in Italy and Lebanon 15 to 19 percent were never asked such questions. In the rest of the countries, nearly all students were taught by teachers whose tests at least sometimes, if not always or almost always, included items based on recall of facts and procedures. Taken as a whole, the results indicate that the tests and examinations advanced mathematics students are administered in these countries typically contain items requiring all four levels of cognitive demand.

