Chapter 6

School Contexts for Advanced Mathematics Learning and Instruction

Chapter 6 presents information about the school contexts for teaching and learning advanced mathematics among the countries that participated in TIMSS Advanced 2008. Considerable research indicates that a school environment conducive to learning is important for students to have high achievement. This chapter describes the school environments in the participating countries and how supportive they may be in helping to bring students to high levels of learning. In particular, information is provided about the principals' roles in their schools and the availability of mathematics teachers, as well as principals' and teachers' perceptions of their schools' climates and of school safety. Information also is provided about the adequacy of resources for teaching advanced mathematics, including the availability of various types of technology.

Much of the data in this chapter was collected through questionnaires administered to schools, and completed by the principals or school heads assisted by school personnel. Results are generally shown as the percentages of students whose schools reported various characteristics. That is, the student is the unit of analysis so that TIMSS Advanced 2008 can describe students' school contexts.

The exhibits have special notations if relatively large percentages of students did not have school questionnaire information. That is, in several cases an "r" is included next to the data because data was available for less than 85 percent of the students, but available for at least 70 percent.

Role of the School Principal and Availability of Mathematics Teachers

Even if a country has established a rigorous and coherent curriculum in advanced mathematics, there are various ways that the school environment can help or hinder classroom instruction in that curriculum. This section presents information about two school staffing issues that can impact students' opportunity to learn the intended curriculum. First, because research shows that achievement improves in schools where principals are effective instructional leaders, data is presented about how principals spend their time. Second, since qualified teachers are important for effective instruction, data is provided about the degree of difficulty schools are having in recruiting mathematics teachers to fill final year vacancies.

Principals that are effective instructional leaders may actively advocate, nurture, and sustain a positive school culture and an education program conducive to students' learning and teachers' professional growth. Because the primary roles that the principal fulfills provide a useful indication of the administrative and educational structures and priorities of the school, the principals of the schools offering advanced mathematics courses were asked how they distributed their time across the competing demands of administrative, instructional, supervisory, disciplinary, teaching, and public relations tasks.

Exhibit 6.1 presents, for each country, the percentage of time that principals reported they would have spent on the different types of

Exhibit 6.1 **Principals' Percent of Time Spent on Various School-related Activities**

TIMSSAdvanced 2008 Advanced Mathematics

Country	Administrative Duties (e.g., Hiring, Budgeting, Scheduling, Meetings)	Instructional Leadership (e.g., Developing Curriculum and Pedagogy)	Supervising and Evaluating Teachers and Other Staff	Issues Related to Student Discipline	Teaching	Public Relations and Fundraising	Other
Armenia	26 (0.2)	21 (0.2)	23 (0.1)	14 (0.2)	7 (0.1)	12 (0.1)	7 (0.1)
Iran, Islamic Rep. of	19 (0.9)	26 (1.1)	20 (0.8)	13 (0.8)	4 (0.5)	10 (0.7)	8 (0.4)
Italy	31 (1.5)	24 (0.9)	17 (0.9)	11 (1.1)	3 (0.6)	12 (0.7)	3 (0.7)
Lebanon	24 (0.6)	18 (0.4)	19 (0.4)	17 (0.4)	6 (0.3)	11 (0.3)	6 (0.3)
Netherlands	r 24 (1.8)	r 23 (1.1)	r 19 (1.1)	r 8 (0.7)	r 7 (1.4)	r 5 (0.6)	r 14 (1.2)
Norway	51 (2.0)	21 (1.2)	9 (0.6)	4 (0.3)	3 (1.0)	6 (0.9)	6 (0.7)
Philippines	25 (1.1)	24 (1.1)	23 (1.0)	10 (0.5)	6 (0.6)	8 (0.6)	4 (0.5)
Russian Federation	27 (1.2)	20 (0.8)	20 (1.0)	6 (0.4)	8 (0.8)	12 (0.7)	8 (0.6)
Slovenia	36 (1.9)	24 (1.6)	12 (0.7)	6 (0.4)	6 (0.6)	9 (0.6)	7 (0.6)
Sweden	43 (1.6)	18 (1.1)	18 (1.1)	8 (0.9)	2 (0.5)	5 (0.5)	8 (1.1)

Data provided by schools.

( ) 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.

school-related tasks by the end of the school year. According to their reports, the vast majority of principals' time is distributed across three broad categories of tasks: administrative duties, providing instructional leadership in the areas of curriculum and pedagogy, and supervising teachers and other staff. Although there was some variation, in Armenia, Iran, Lebanon, the Netherlands, the Philippines, and the Russian Federation, the distribution of time was similar across these three categories (about one fifth to one fourth of the principals' time spent on each of the three areas). In comparison, in Italy and Slovenia principals reported devoting relatively more of their time (about one third) to administrative duties, about one fourth to instructional leadership, and a relatively less time to supervising and evaluating teachers. The distribution of time across these three areas was least balanced in Norway and Sweden, with principals' time considerably skewed toward the administrative side (51% and 43%, respectively). Although the percentages were not large, across the countries principals typically reported as much if not more time devoted to disciplining students (4 to 17%) than to teaching them the schools' curriculum (2 to 8%). Public relations took from 10 to 12 percent of the principals' time in Armenia, Iran, Italy, Lebanon, and the Russian Federation, but smaller percentages of time in the other countries.

Exhibit 6.2 presents schools' reports about the degree of difficulty they are having recruiting mathematics teachers to fill vacancies in the final year of secondary school. As discussed in Chapter 5, substantial percentages of the teachers of advanced mathematics have been teaching for 25 years or so in several of the TIMSS Advanced 2008 countries, and thus could be expected to be considering retirement. Also, as evidenced by the TIMSS Advanced data, there are not large pools of students currently being trained in advanced mathematics and few of them plan to continue their study of mathematics (Exhibits 4.14

Exhibit 6.2 **School's Reports on Mathematics Teacher Recruitment**

TIMSSAdvanced 2008 Advanced Mathematics

Country	Filling Mathematics Teaching Vacancies for the School Year							
	No Vacancies		Easy to Fill Vacancies		Somewhat Difficult to Fill Vacancies		Very Difficult to Fill Vacancies	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	89 (0.8)	422 (3.6)	2 (0.1)	~ ~	5 (0.1)	586 (17.8)	4 (0.9)	515 (17.8)
Iran, Islamic Rep. of	23 (3.5)	506 (13.9)	25 (4.4)	469 (11.2)	39 (5.0)	502 (11.3)	13 (3.4)	515 (15.4)
Italy	51 (5.4)	438 (10.5)	27 (5.2)	452 (12.6)	18 (5.4)	465 (15.9)	3 (2.4)	490 (10.0)
Lebanon	48 (2.2)	545 (3.3)	16 (1.8)	563 (7.2)	23 (2.1)	538 (3.8)	13 (1.7)	529 (4.1)
Netherlands r	55 (5.8)	551 (3.3)	9 (2.4)	559 (9.8)	26 (5.3)	552 (5.1)	10 (2.8)	557 (9.7)
Norway	27 (5.6)	450 (6.9)	33 (4.5)	451 (6.8)	31 (5.5)	429 (8.9)	9 (2.8)	406 (18.4)
Philippines	26 (5.2)	353 (12.4)	32 (4.8)	348 (11.3)	33 (5.6)	353 (11.0)	9 (3.2)	399 (20.1)
Russian Federation	80 (4.3)	559 (8.4)	13 (2.9)	574 (12.9)	4 (1.9)	566 (18.7)	3 (2.0)	539 (66.1)
Slovenia	77 (4.9)	460 (4.6)	22 (4.9)	451 (9.7)	1 (0.0)	~ ~	0 (0.0)	~ ~
Sweden	39 (5.0)	406 (8.9)	51 (5.5)	414 (8.6)	10 (2.9)	431 (14.0)	0 (0.0)	~ ~

Country	Incentives to Recruit or Retain Mathematics Teachers			
	School Uses Incentives		School Does Not Use Incentives	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	18 (0.8)	442 (3.7)	82 (0.8)	431 (4.3)
Iran, Islamic Rep. of	39 (4.2)	515 (12.4)	61 (4.2)	484 (7.0)
Italy	– –	– –	– –	– –
Lebanon	34 (2.2)	553 (4.7)	66 (2.2)	540 (2.4)
Netherlands r	9 (3.1)	551 (8.2)	91 (3.1)	553 (2.9)
Norway	5 (2.0)	436 (16.6)	95 (2.0)	439 (5.2)
Philippines	33 (5.8)	369 (11.8)	67 (5.8)	348 (7.8)
Russian Federation	74 (4.4)	561 (7.4)	26 (4.4)	562 (15.6)
Slovenia	1 (0.9)	~ ~	99 (0.9)	459 (4.3)
Sweden	1 (0.7)	~ ~	99 (0.7)	413 (5.5)

Data provided by schools.

( ) 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.

and 4.15), which would indicate even smaller percentages planning to become teachers. Since there does not seem to be a regular pipeline into the career of teaching advanced mathematics in a number of the TIMSS Advanced 2008 countries, it is not surprising that advanced mathematics students in some participating countries are attended schools that are having some difficulty recruiting mathematics teachers for the final year of secondary school.

In several countries, most advanced mathematics students were in schools with hardly any vacancies for mathematics teachers in the final year of secondary school, including Armenia (89%), the Russian Federation (80%), and Slovenia (77%). In contrast, however, half the Iranian advanced mathematics students in their final year of secondary school were attending schools with vacancies for mathematics teachers that were at least somewhat difficult to fill as were about 40 percent or so of the Norwegian and Philippine students, and a little over one third of the Lebanese and Dutch students.

As shown in the lower portion of Exhibit 6.2, schools were asked if they used any incentives (e.g., pay, housing, signing bonuses, smaller classes) to recruit or maintain mathematics teachers for students in the final year of secondary school. The results indicate that incentives were used most widely in the Russian Federation, and apparently with some success since nearly all vacancies were filled as discussed above. Iran, Lebanon, and the Philippines also reported some use of incentives. Neither the percentage of difficult-to-fill vacancies nor the use of incentives was systematically related to average achievement in advanced mathematics.

Orderly and Safe Schools

Although an orderly and safe school environment does not, in and of itself, guarantee high levels of student achievement, safe schools can be considered a necessary condition for providing a good learning environment for students. TIMSS 2007 showed that mathematics achievement was related to teachers' and students' perceptions about how safe they felt at school at both the fourth and eighth grades, and it might be anticipated that school discipline and behavior problems in secondary schools might be of even greater concern. However, the TIMSS Advanced 2008 results indicate that school safety generally is not a problem for the select populations of final year students studying advanced mathematics. According to their principals and teachers, these students generally are in orderly and safe school environments.

To provide an initial context for considering the degree of order and safety in the schools attended by students studying advanced mathematics, TIMSS Advanced 2008 asked principals to rate the seriousness of the following behavior problems among final year students in their schools: vandalism, theft, intimidation or verbal abuse among students, students causing physical injury to other students, students intimidating or verbally abusing teachers, and students physically injuring teachers or staff. TIMSS Advanced used the principals' responses about each behavior (i.e., not a problem, minor problem, or serious problem) to create an Index of Good Behavior at School for Students in the Final Year of Secondary School. Students in the high category attended schools where principals reported that *none* of these six behaviors were a problem. In contrast, students in the low category attended schools where principals reported widespread minor and/or serious behavior problems. The medium category included students attending schools where these behaviors were minor problems.

Exhibit 6.3 presents the results for the Index of Good Behavior at School for Students in the Final Year of Secondary School. The countries are presented in order from the largest to smallest percentage of students in the high category. In six countries, the majority of students (from 51 to 78%) were in the high category; that is, attended schools where *none* of these student behaviors were even minor problems according to principals. From 29 to 40 percent of the students attended such "problem-free" schools in Lebanon, Italy, the Philippines, and Sweden. Most notably, no more than 8 percent of the students in any country were in the low category; that is, attending schools where principals considered these student behaviors—including physical conflicts—to be widespread or serious problems. In Iran and Slovenia, students in the schools with no behavior problems had higher achievement than their counterparts in schools with minor or major behavior problems.

Exhibit 6.4 presents the results of the Index of Mathematics Teachers' Perceptions of Safety in Their Schools. The index is based on mathematics teachers' responses to three statements pertaining directly to being safe in their schools:

- This school is located in a safe neighborhood
- I feel safe at this school
- The school's security policies and practices are sufficient.

Students were assigned to the high level when their teachers agreed with all three statements and to the low category when their teachers disagreed with all three. Students whose teachers provided other response combinations were assigned to the medium category. The results are presented according the percentage of students in the high category from largest to smallest.

Exhibit 6.3 Index of Good Behavior at School for Students in the Final Year of Secondary School (GBS)

TIMSSAdvanced 2008 Advanced Mathematics

Country	High GBS		Medium GBS		Low GBS	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	78 (0.5)	430 (4.7)	20 (0.5)	450 (3.8)	3 (0.1)	396 (16.9)
Russian Federation	73 (4.3)	561 (8.0)	27 (4.3)	561 (12.1)	0 (0.0)	~ ~
Iran, Islamic Rep. of	71 (4.1)	503 (7.3)	29 (4.1)	478 (10.6)	0 (0.0)	~ ~
Netherlands r	63 (4.6)	553 (3.7)	37 (4.6)	552 (3.3)	0 (0.0)	~ ~
Norway	54 (5.4)	434 (6.0)	46 (5.4)	447 (8.1)	0 (0.0)	~ ~
Slovenia	51 (6.0)	470 (7.7)	47 (6.0)	446 (6.8)	2 (0.9)	~ ~
Lebanon	40 (2.5)	541 (4.0)	52 (2.5)	550 (3.2)	8 (0.4)	537 (7.0)
Italy	37 (5.7)	447 (11.2)	57 (5.8)	457 (9.6)	6 (2.5)	384 (30.7)
Philippines	31 (4.3)	357 (12.2)	68 (4.3)	354 (7.0)	1 (1.0)	~ ~
Sweden	29 (5.0)	420 (7.0)	66 (5.5)	407 (7.7)	5 (2.7)	427 (20.8)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on principals' responses about the seriousness of following behaviors in their school: vandalism, theft, intimidation or verbal abuse of other students, physical injury to other students, students intimidating or verbally abusing teachers or staff, and students causing physical injury to teachers or staff. Principals' responses were averaged across the six statements based on a 3-point scale: 1=Not a Problem, 2=Minor Problem, 3=Serious Problem. Students in the high category attended schools where principals reported none of these problems with students behavior (average of 1). Students in the low category attended schools where principals reported widespread minor and/or serious student behavior problems (average greater than 2). Students in the medium category attended schools where principals reported minor student behavior problems (average greater than 1 and less than or equal to 2).

( ) 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.

Exhibit 6.4 Index of Advanced Mathematics Teachers' Perceptions of Safety in Their Schools (TPSS)

TIMSSAdvanced 2008 Advanced Mathematics

Country	High TPSS		Medium TPSS		Low TPSS	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Iran, Islamic Rep. of	99 (0.7)	497 (6.2)	1 (0.0)	~ ~	0 (0.0)	~ ~
Netherlands	96 (2.1)	553 (2.7)	4 (2.1)	539 (8.1)	0 (0.0)	~ ~
Sweden	94 (2.5)	416 (5.8)	6 (2.5)	409 (16.1)	0 (0.0)	~ ~
Norway	94 (4.0)	440 (5.1)	6 (4.0)	422 (48.2)	0 (0.0)	~ ~
Philippines	92 (2.3)	350 (5.7)	8 (2.3)	410 (24.0)	0 (0.0)	~ ~
Armenia	91 (2.0)	435 (3.8)	8 (2.0)	396 (15.4)	1 (0.0)	~ ~
Lebanon	88 (1.6)	546 (2.5)	11 (1.5)	541 (7.4)	1 (0.5)	~ ~
Italy	86 (3.2)	453 (8.2)	12 (2.9)	433 (13.4)	2 (1.4)	~ ~
Slovenia	85 (3.7)	463 (4.9)	14 (3.6)	435 (14.1)	1 (0.0)	~ ~
Russian Federation	80 (4.1)	566 (8.0)	20 (4.0)	544 (11.5)	1 (0.1)	~ ~

SOURCE: IEA TIMSS Advanced 2008 ©

Based on teachers' responses to three statements about their schools: 1)This school is located in a safe neighborhood; 2) I feel safe at this school; 3) This school's security policies and practices are sufficient. Teachers' responses were averaged across the three statements based on a 4-point Likert scale: 1=Agree a lot; 2=Agree; 3=Disagree; 4=Disagree a lot. Students were assigned to the high level when their teachers agreed or agreed a lot with all three statements and to the low category when their teachers disagreed or disagreed a lot with all three. Students whose teachers provided other response combinations were assigned to 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.

Nearly all teachers of advanced mathematics students agreed that the schools offering courses in advanced mathematics were safe. In six countries, more than 90 percent of the advanced mathematics students were attending schools judged to be safe by their teachers, and in the other four countries, 80 to 88 percent of the students were attending such schools. The pattern was for advanced mathematics students in schools where teachers perceived "medium" safety concerns to have lower average achievement than their counterparts attending schools in the high category (except in the Philippines).

Principals' and Teachers' Perceptions of School Climate

Beyond an orderly and safe environment, a positive school climate supportive of teaching and learning helps to build better morale among teachers and students, encourages students to concentrate on their studies, and creates an expectation for high levels of academic success, all of which lead to higher student achievement. TIMSS Advanced 2008 asked both school principals and teachers to characterize the climate of their school according to important indicators of an environment conducive to learning. The principals and the teachers were asked to rate each of the following school characteristics on a 4-point scale from *very high* to *very low*.

- Teachers' job satisfaction
- Teachers' understanding of the school's curricular goals
- Teachers' degree of success in implementing the school's curriculum
- Teachers' expectations for student achievement
- Parental support for student achievement
- Parental involvement in school activities

- Students' regard for school property
- Students' desire to do well in school.

Based on the responses provided by the principals and teachers, respectively, TIMSS Advanced created two comparable scales: the Index of Principals' Perception of School Climate and the Index of Advanced Mathematics Teachers' Perception of School Climate. In each case, advanced mathematics students were assigned to the high level if their principals or teachers, respectively, averaged a *high* or *very high* rating on these aspects of school climate, and to the low level if their principals or teachers, respectively, averaged *low* or *very low*. Students in the medium category had principals or teachers with other response combinations.

Exhibit 6.5 presents the results for the Index of Principals' Perception of School Climate, including the percentage of students at each level of the index in each country, together with their average achievement in advanced mathematics. The countries are ordered according to the percentage of students in the high category. In every country, except the Philippines, there was a positive association between a climate more supportive of student learning and higher average achievement in advanced mathematics. In most of the other countries, average mathematics achievement was highest among students at the high level of the principals' perception of school climate index, next highest at the medium level, and lowest at the low level.

In five countries, 90 percent or more of the advanced mathematics students were in schools whose principals reported learning climates categorized as high or medium, including the Philippines, Slovenia, Sweden, the Russian Federation, and Norway. The largest percentage of students in the high category was in the Philippines with more than half (53%). About one fourth of the students were in schools with learning

Exhibit 6.5 Index of Principals' Perceptions of School Climate (PPSC)

TIMSSAdvanced2008 Advanced Mathematics

Country	High PPSC		Medium PPSC		Low PPSC	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Philippines	53 (5.3)	354 (7.8)	43 (4.5)	365 (9.8)	4 (2.2)	303 (28.8)
Slovenia	25 (3.6)	506 (6.1)	68 (4.4)	447 (6.0)	6 (2.6)	405 (8.3)
Iran, Islamic Rep. of	25 (4.0)	528 (14.0)	59 (5.2)	496 (9.1)	16 (3.7)	449 (6.4)
Lebanon	25 (2.0)	558 (4.6)	59 (2.1)	543 (3.1)	16 (1.3)	525 (3.7)
Sweden	18 (4.9)	438 (11.0)	73 (4.8)	411 (6.2)	10 (3.3)	381 (9.0)
Russian Federation	13 (3.4)	605 (18.6)	81 (3.8)	559 (6.7)	6 (2.0)	494 (24.7)
Norway	7 (2.7)	441 (11.2)	90 (3.3)	440 (5.1)	4 (1.9)	403 (58.4)
Italy	3 (1.8)	481 (45.6)	60 (5.1)	458 (8.7)	37 (5.0)	431 (12.4)
Armenia	2 (0.1)	~ ~	83 (0.4)	436 (4.1)	15 (0.4)	420 (5.3)
Netherlands r	1 (0.7)	~ ~	68 (5.5)	555 (3.7)	31 (5.5)	547 (3.7)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on principals' responses to the following aspects of school climate in their schools: teachers' job satisfaction, teachers' opportunities for professional development, teachers' understanding of the school's curricular goals, teachers' degree of success in implementing the school's curriculum, teachers' expectations for student achievement, parental support for student achievement, parental involvement in school activities, students' regard for school property, and students' desire to do well in school. Average is computed across the nine statements based on a 5-point scale: 1 = Very High, 2 = High, 3 = Medium, 4 = Low, 5 = Very Low. High level indicates students whose principals' perception of their school climate was very positive (average is less than or equal to 2). Medium level indicates students whose principals' perception of their school climate was moderately positive (average is greater than 2 and less than 3). Low level indicates students whose principals' perception of their school climate was not so positive (average is greater than or equal to 3).

( ) 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.

Exhibit 6.6 Index of Advanced Mathematics Teachers' Perceptions of School Climate (TPSC)

TIMSSAdvanced2008 Advanced Mathematics

Country	High TPSC		Medium TPSC		Low TPSC	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Philippines	37 (5.1)	372 (10.8)	52 (5.4)	344 (9.3)	11 (2.7)	355 (22.2)
Lebanon	31 (2.1)	557 (4.3)	47 (1.8)	546 (2.9)	22 (1.9)	526 (4.7)
Iran, Islamic Rep. of	21 (3.2)	529 (13.5)	49 (4.4)	497 (8.6)	29 (3.8)	474 (7.1)
Sweden	16 (3.8)	428 (12.2)	68 (4.8)	421 (6.1)	17 (3.6)	383 (13.5)
Norway	11 (3.7)	450 (18.4)	62 (5.1)	433 (6.2)	27 (4.7)	450 (7.2)
Slovenia	9 (3.5)	491 (16.9)	60 (5.6)	471 (5.9)	31 (4.8)	418 (7.4)
Russian Federation	8 (2.6)	616 (13.4)	73 (3.3)	564 (8.2)	20 (3.4)	527 (10.2)
Armenia	6 (1.3)	434 (18.7)	61 (3.9)	451 (6.7)	33 (3.7)	402 (8.6)
Italy	4 (1.7)	502 (25.3)	37 (5.2)	456 (11.5)	59 (5.2)	440 (9.1)
Netherlands	2 (1.2)	~ ~	59 (5.3)	555 (3.1)	40 (5.2)	551 (4.0)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on teachers' responses to the following aspects of school climate in their schools: teachers' job satisfaction, teachers' understanding of the school's curricular goals, teachers' degree of success in implementing the school's curriculum, teachers' expectations for student achievement, support for teachers' professional development, parental support for student achievement, parental involvement in school activities, students' regard for school property, and students' desire to do well in school. Average is computed across the nine statements based on a 5-point scale: 1 = Very High, 2 = High, 3 = Medium, 4 = Low, 5 = Very Low. High level indicates students whose teachers' perception of their school climate was very positive (average is less than or equal to 2). Medium level indicates students whose teachers' perception of their school climate was moderately positive (average is greater than 2 and less than 3). Low level indicates students whose teachers' perception of their school climate was not so positive (average is greater than or equal to 3).

( ) 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.

climates categorized as high in Slovenia, Lebanon, and Iran. Across countries, Italian and Dutch principals had the lowest perceptions of the climates in their schools. According to principals, few (1–3%) of the advanced mathematics students in Italy and the Netherlands were in schools with learning climates categorized as high and about one third (31–37%) were in schools with climates categorized as low.

Exhibit 6.6 presents the results for the Index of Advanced Mathematics Teachers' Perceptions of School Climate and, in general, they correspond to the results for the Index of Principals' Perceptions of School Climate described above. Similar to the findings for the principals' index of school climate, average achievement in advanced mathematics was positively related to teachers' perceptions of school climate in a number of the participating countries, with the exception of the Philippines, Norway, and Armenia, where the patterns were not consistent.

Three of the countries with the highest percentages of advanced mathematics students in the high category according to their teachers are the same as they were according to principals—the Philippines, Lebanon, and Iran. Interestingly, however, Slovenian teachers (9 percent of advanced mathematics students in the high category) were quite a bit less positive about their school climates than were the Slovenian principals (25 percent in the high category). Although the cross-country differences between teachers' and principals' perceptions typically were not as large as in Slovenia, teachers tended to be less positive about their school climates than principals. According to teachers, from 20 to 40 percent of students were in schools categorized as low in 7 out of 10 countries. Agreeing with their principals, the Italian teachers were the least positive across countries about their school climates and, consistent with the cross-country pattern, were even somewhat less positive than their principals. According to their

teachers, only 4 percent of the advanced mathematics students in Italy were in schools with climates categorized as high (in agreement with principals' reports of 3%) and 59 percent were in schools with climates categorized as low (compared to principals' estimates of 37%).

As an additional indication of whether the school had an environment supportive of high academic learning, principals were asked whether these schools that were offering courses in advanced mathematics had policies for encouraging students to choose advanced mathematics courses. Exhibit 6.7 presents the results for each country for the percentage of students in schools with advanced mathematics courses that specifically encouraged students to study advanced mathematics. Average achievement in advanced mathematics is shown for schools with such policies and for schools that did not have such policies.

The extremes are represented by the Philippines and the Russian Federation at one end of the continuum, with 96 to 100 percent of advanced mathematics students in schools expressly encouraging students to study advanced mathematics, and Sweden, at the other end of the continuum, where none of the schools had such a policy, presumably because, as explained in Exhibit 1.1, choices about studying advanced mathematics are left to the students. Across the seven countries where some of the schools with students enrolled in advanced mathematics had "encouraging" policies and others did not, all three possible relationships with average achievement were represented. In Armenia and Norway, students in schools with such policies had lower average achievement—perhaps the underlying reason for the policy of encouragement. In contrast, Iranian students in schools with specific policies had higher average achievement than their counterparts in schools without such policies. In the remaining countries, there was little difference in average achievement between the two types of schools.

Exhibit 6.7 **Schools' Policies for Encouraging Students to Study Advanced Mathematics**

TIMSSAdvanced 2008 Advanced Mathematics

Country	School Has Policy		School Does Not Have Policy	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	57 (0.8)	410 (5.2)	43 (0.8)	469 (5.2)
Iran, Islamic Rep. of	73 (4.5)	504 (7.8)	27 (4.5)	476 (10.8)
Italy	44 (6.2)	449 (10.0)	56 (6.2)	448 (9.8)
Lebanon	64 (2.2)	545 (2.9)	36 (2.2)	540 (4.1)
Netherlands	23 (5.7)	548 (7.3)	77 (5.7)	554 (2.8)
Norway	27 (6.0)	422 (12.6)	73 (6.0)	445 (4.9)
Philippines	100 (0.0)	355 (5.5)	0 (0.0)	~ ~
Russian Federation	96 (1.9)	560 (7.3)	4 (1.9)	594 (56.4)
Slovenia	36 (5.3)	467 (8.9)	64 (5.3)	454 (5.0)
Sweden	0 (0.0)	~ ~	100 (0.0)	412 (5.5)

SOURCE: IEA TIMSS Advanced 2008 ©

Data provided by schools.

( ) 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.

School Resources and Technology

The last section of this chapter presents information about the range of resources available in schools providing instruction in advanced mathematics. Curriculum implementation can be made easier by ready access to the facilities, materials, and equipment necessary to achieve the specified learning goals. Results from successive TIMSS assessments indicate that fourth and eighth grade students attending schools that are well resourced generally have higher achievement than those in schools where shortages of resources affect teachers' capacity to implement the curriculum. In addition to schools' reports about the adequacy of general resources and resources particularly targeted to mathematics instruction, this section includes data about school availability of computers and Internet access for final year students.

To gather information about whether the lack of availability of school resources had an adverse impact on instruction in advanced mathematics, TIMSS Advanced 2008 queried principals about the degree to which shortages or inadequacies in six general areas affected their school's capacity to provide instruction: instructional materials (textbooks, for example); budget for supplies (paper, pencils, etc.); school buildings and grounds; heating/cooling and lighting systems; instructional space (classrooms, for example); and special equipment for students with disabilities. Principals also responded to questions about whether shortages or inadequacies in five resource areas specifically pertaining to mathematics instruction affected their school's capacity to provide instruction: computers for mathematics instruction; computer software for mathematics instruction; calculators for mathematics instruction; library materials relevant to mathematics instruction; and audio-visual resources for mathematics instruction. Responses to both types of questions were provided on a 4-point scale:

no, *a little*, *some*, and *a lot*. TIMSS Advanced created two indices based on principals' responses to the two groups of questions about school resource shortages—one concerning shortages in general areas and the other concerning shortages in resources specifically related to mathematics instruction.

To create the Index of Adequacy of General School Resources, principals' responses were averaged across the six questions about shortages in general resources, and to create the Index of Adequacy of Resources Specifically for Mathematics Instruction, principals' responses were averaged across the five questions about shortages in resources pertaining specifically to mathematics instruction. For each of the two indices, students were placed in the high category if principals responded that shortages in resources affected the capacity to provide instruction only a little, if at all (average less than 2). In contrast, students were placed in the low category if principals responded that resource shortages had considerable impact on the schools' capacity to provide instruction (i.e., across all resource areas to some degree and/or shortages in several areas adversely affected instruction a lot (average 3 or higher)). Students in the medium category were in schools where the capacity to provide instruction was somewhat adversely affected by the lack of some resources.

Exhibit 6.8 displays the results for the Index of Adequacy of General School Resources for each country ordered by the percentage of students in the high category. As would be anticipated based on the range in the economic indicators for the participating countries, there was considerable variability in principals' responses across countries. Approximately three fourths (73 to 79%) of the students studying advanced mathematics attended schools in the high category in Sweden, Armenia, and the Netherlands; just under two thirds (65%) in the Russian Federation and Italy; approximately three fifths (59 to 62%)

Exhibit 6.8 **Index of Adequacy of General School Resources (Shortages Do Not Affect Capacity to Provide Instruction) (AGSR)**

TIMSSAdvanced 2008 Advanced Mathematics

Country	High AGSR		Medium AGSR		Low AGSR	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Sweden	79 (5.4)	411 (6.3)	19 (5.4)	425 (9.7)	2 (1.1)	~ ~
Armenia	75 (0.5)	436 (3.8)	17 (0.4)	412 (9.1)	9 (0.3)	447 (13.7)
Netherlands r	73 (5.2)	550 (3.0)	27 (5.2)	560 (5.3)	0 (0.0)	~ ~
Russian Federation	65 (5.1)	560 (8.6)	29 (4.8)	563 (10.7)	5 (2.4)	576 (17.8)
Italy	65 (6.0)	447 (8.8)	28 (5.6)	451 (14.4)	7 (3.0)	453 (43.8)
Lebanon	62 (2.4)	547 (2.9)	27 (2.2)	535 (4.8)	10 (1.4)	547 (4.1)
Slovenia	60 (6.6)	457 (6.9)	26 (4.7)	455 (9.5)	14 (4.9)	468 (15.2)
Iran, Islamic Rep. of	59 (5.0)	508 (9.3)	29 (4.6)	489 (11.7)	12 (3.2)	458 (12.0)
Norway	50 (5.6)	434 (7.1)	43 (5.5)	445 (7.5)	7 (3.3)	442 (23.2)
Philippines	45 (4.6)	376 (9.6)	35 (4.3)	338 (11.6)	20 (4.0)	339 (11.5)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on principals' responses to how much the school's capacity to provide instruction is affected by shortages or inadequacies of the following: instructional materials (e.g., textbooks), budget for supplies (e.g., paper, pencils), school buildings and grounds, heating/cooling and lighting systems, instructional space (e.g., classrooms), and special equipment for students with disabilities. Principals' responses were averaged across the six statements based on a 4-point scale: 1 = No, 2 = A little, 3 = Some, 4 = A lot. Students were placed in the high category if principals responded that shortages in general resources affected only a little, if at all (average is less than 2). Students were placed in the low category if principals responded that shortages in all the general resource areas had some adverse affect on capacity to provide instruction and/or shortages in several general resource areas adversely affected instruction a lot (average is greater than or equal to 3). Students in the medium category were in schools where the capacity to provide instruction was adversely affected somewhat by the lack of general resources (average is greater than or equal to 2 and less than 3).

( ) 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.

Exhibit 6.9 **Index of Adequacy of Resources Specifically for Mathematics Instruction (Shortages Do Not Affect Capacity to Provide Instruction) (ARMI)**

TIMSSAdvanced 2008 Advanced Mathematics

Country	High ARMI		Medium ARMI		Low ARMI	
	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Sweden	75 (3.3)	412 (7.0)	25 (3.3)	416 (8.4)	0 (0.0)	~ ~
Netherlands r	72 (5.4)	552 (2.8)	28 (5.3)	554 (5.8)	1 (0.7)	~ ~
Norway	68 (5.7)	439 (5.8)	32 (5.7)	441 (8.5)	0 (0.0)	~ ~
Italy	57 (6.1)	450 (7.7)	41 (6.1)	450 (13.0)	2 (1.5)	~ ~
Russian Federation	49 (4.7)	565 (9.3)	41 (4.1)	564 (12.2)	10 (3.0)	538 (15.1)
Slovenia	48 (5.6)	471 (7.8)	44 (5.0)	449 (6.6)	8 (2.8)	444 (29.8)
Armenia	45 (0.7)	431 (5.9)	45 (0.7)	444 (4.7)	10 (0.3)	390 (9.1)
Lebanon	44 (2.5)	546 (3.8)	35 (2.2)	545 (3.6)	21 (2.2)	536 (4.7)
Iran, Islamic Rep. of	36 (4.2)	518 (13.9)	41 (4.4)	487 (7.3)	23 (3.9)	479 (10.2)
Philippines	31 (5.4)	362 (11.7)	27 (4.5)	379 (14.8)	43 (5.5)	336 (10.5)

SOURCE: IEA TIMSS Advanced 2008 ©

Based on principals' responses to how much the school's capacity to provide mathematics instruction is affected by shortages or inadequacies of the following: computers for mathematics instruction, computer software for mathematics instruction, calculators for mathematics instruction, library materials relevant to mathematics instruction, audio-visual resources for mathematics instruction. Principals' responses were averaged across the five areas based on a 4-point scale: 1 = No, 2 = A little, 3 = Some, 4 = A lot. Students were placed in the high category if principals responded that shortages in resources specifically related to mathematics instruction affected the capacity to provide instruction only a little, if at all (average is less than 2). Students were placed in the low category if principals responded that shortages in all the mathematics related areas had some adverse affect on capacity to provide instruction and/or shortages in several mathematics related areas adversely affected instruction a lot (average is greater than or equal to 3). Students in the medium category were in schools where the capacity to provide instruction was adversely affected somewhat by the lack of mathematics related resources (average 2 or higher but less than 3).

( ) 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.

in Lebanon, Slovenia, and Iran; half in Norway; and under half (45%) in the Philippines. From 10 to 14 percent of the advanced mathematics students in Lebanon, Slovenia, and Iran as well as 20 percent in the Philippines were in the low category. Iran had the strongest relationship between a higher level of adequacy of general resources and higher average achievement in advanced mathematics.

Exhibit 6.9 shows the results for the Index of Adequacy of Resources Specifically for Mathematics Instruction. In a number of the countries principals reported more adverse affects on instruction from shortages in resources specifically for mathematics instruction than from shortages in general resources, although there was a similar variability in the results. Because the mathematics related resource areas primarily were technology related (i.e., computer hardware and software, calculators, and audio-visual resources), it makes sense that schools might have more difficulty keeping up-to-date in these areas. Norway was the only country where principals reported a higher percentage (68%) of advanced mathematics students in the high category for adequacy of mathematics specific instructional resources (little, if any adverse impact on their instruction due to shortages) than in the high category for adequacy of general resources (50%).

Sweden and the Netherlands appear to be well-resourced in mathematics related instructional materials and equipment as well as in general areas. Similar to the results for general resources described above, about three fourths (72 to 75%) of the Swedish and Dutch students studying advanced mathematics were in the high category for adequacy of mathematics related resources. Also, similar to the Philippine results for general resources, the principals reported considerable adverse impact on instruction as a result of shortages in mathematics related resources, and an even greater percentage of students (43%) in the low category. From 21 to 23 percent of the

advanced mathematics students in Iran and Lebanon were in the low category for adequacy of mathematics instructional resources as were 10 percent in Armenia and the Russian Federation.

Exhibit 6.10 presents information about the degree to which schools offering advanced mathematics courses had computers and access to the Internet. The first data column for each country provides the average number of computers in the schools available for use by final year students. Care should be taken in interpreting these results because these computers most likely are not for the exclusive use of final year students and could also be used by other students attending the schools, and the total number of students having access to the computers in each school most likely varies depending on such factors as the type of school and size of school enrollment.

Taking the above caveats into consideration, there still was a considerable range in the results. For schools with advanced mathematics courses, Sweden reported an average of 209 computers per school available for use by final year students, and the Netherlands and Norway, respectively, reported 112 and 121 computers per school on average. In the other participating countries, however, principals of schools with advanced mathematics courses reported less computer availability for final year students: Italy reported an average of 60 computers per school, the Philippines and Slovenia reported averages of 46 and 42, respectively, the Russian Federation reported an average of 35 computers per school, Lebanon reported 27, and Armenia reported 15. Computers were even rarer in Iran, with only 8 per school on average.

The remaining data columns in Exhibit 6.10 provide information about Internet access in schools. It shows the percentages of advanced mathematics students in each country attending schools where "all", "most", "some", or "none" of the school computers available for their use had Internet access, together with the average achievement for students

Exhibit 6.10: **Computer Availability and Internet Access in School**

TIMSSAdvanced 2008 Advanced Mathematics

Country	Average Number of Computers Available for Use by Final Year Students	Internet Access for Educational Purposes							
		All Computers		Most Computers		Some Computers		No Computers	
		Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement	Percent of Students	Average Achievement
Armenia	15 (0.2)	40 (0.7)	454 (5.3)	19 (0.8)	438 (4.6)	16 (0.4)	402 (11.6)	25 (0.6)	416 (5.8)
Iran, Islamic Rep. of	8 (0.7)	33 (4.6)	508 (11.8)	8 (2.7)	557 (26.0)	29 (4.7)	496 (11.8)	29 (4.3)	467 (10.5)
Italy	60 (6.0)	83 (4.1)	453 (7.6)	12 (3.5)	413 (17.0)	3 (1.7)	487 (48.5)	1 (0.1)	~ ~
Lebanon	27 (0.7)	33 (2.2)	558 (3.6)	15 (1.4)	555 (4.6)	22 (2.5)	540 (6.2)	30 (2.4)	530 (4.2)
Netherlands r	112 (8.8)	r 85 (4.3)	554 (3.0)	15 (4.3)	548 (7.0)	0 (0.0)	~ ~	0 (0.0)	~ ~
Norway	121 (10.2)	91 (4.6)	441 (5.5)	9 (4.6)	424 (23.6)	0 (0.0)	~ ~	0 (0.0)	~ ~
Philippines	46 (4.3)	45 (6.1)	380 (11.3)	17 (4.5)	323 (15.0)	30 (4.6)	351 (11.6)	8 (2.2)	309 (15.3)
Russian Federation	35 (2.0)	50 (5.6)	559 (10.3)	33 (4.3)	563 (9.0)	17 (4.3)	563 (12.1)	0 (0.0)	~ ~
Slovenia	42 (4.6)	88 (4.2)	458 (4.5)	12 (4.2)	465 (14.6)	0 (0.0)	~ ~	0 (0.0)	~ ~
Sweden	209 (19.4)	89 (3.3)	414 (6.0)	11 (3.3)	409 (10.5)	0 (0.0)	~ ~	0 (0.0)	~ ~

Data provided by schools.

( ) 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

in each category. In Italy, the Netherlands, Norway, Slovenia, and Sweden, from 83 to 91 percent of the advanced mathematics students were attending schools where all of the computers had Internet access, and (except for 3% in Italy) the rest of the students were in schools where most computers had Internet access.

In Iran and Lebanon, the two participating countries reporting the least Internet access in schools, one third of the advanced mathematics students were in schools where all the computers had Internet access, and a few more (8% and 15%, respectively) were in schools where most computers had Internet access. However, according to the last column in Exhibit 6.10, approximately 30 percent of the advanced mathematics students in Iran and Lebanon as well as 25 percent in Armenia attended schools where no computers had Internet access, and these students had lower average achievement than their counterparts in schools where all or most of the computers had Internet access.

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