

Chapter 2

Developing the TIMSS Advanced 2008 Instruments

Alka Arora and Ina V.S. Mullis

2.1 Introduction

Developing the TIMSS Advanced 2008 assessment began with work on the assessment framework in January 2006 and continued until July 2007, when the international version of the assessment was finalized for data collection. The development was a collaborative process involving the National Research Coordinators (NRCs) and item developers from participating countries. The process was managed by the TIMSS & PIRLS International Study Center staff with expert advice and guidance provided by the international coordinators Robert Garden for advanced mathematics and Svein Lie for physics, as well as the TIMSS Advanced Task Force members. The task force included both subject coordinators; staff from the TIMSS & PIRLS International Study Center; Wolfgang Dietrich from the National Agency of Education in Sweden; Torgier Onstad, Carl Angell, and Liv Sissel Gronmo from University of Oslo, Norway; and Helen Lye from Australian Council of Educational Research, Australia.



TIMSS Advanced 2008 was the second cycle of this assessment for advanced mathematics and physics students in their final year of secondary school and built on the first time this population was tested in TIMSS 1995. Since this is a trend study, TIMSS Advanced 2008 is structured so it includes new material, as well as the material from the 1995 assessment. Following the release of the 1995 results, half of the advanced mathematics and physics items were released. The replacement items were developed to include a wide distribution of items, as specified in the frameworks (see next section).

Experts from various participating countries contributed to developing the items. Items were reviewed and, if needed, revised by task force members. NRCs were responsible for final approval of the field-test items, and a field test was conducted in February–March 2007. The field test provided important information about the measurement properties of the items across the countries. Based on that information, items were selected and finalized for the TIMSS Advanced 2008 data collection. This chapter describes in detail the instrument development process. An overview of the process is shown in Exhibit 2.1.

Exhibit 2.1 Overview of the TIMSS Advanced 2008 Frameworks and Instrument Development Process

| Date(s) | Group and Activity |
|-----------------------|--|
| January–February 2006 | TIMSS & PIRLS International Study Center began work on TIMSS Advanced 2008 Assessment Frameworks |
| March 2006 | TIMSS & PIRLS International Study Center sent draft frameworks to National Research Coordinators for their review and recommendations |
| March–April 2006 | Experts from the participating countries began developing field test items |
| May 2006 | 1st National Research Coordinators Meeting (Amsterdam) finalized frameworks and reviewed field test item pool |
| August 2006 | TIMSS & PIRLS International Study Center published the TIMSS Advanced 2008 Assessment Frameworks |
| September 2006 | 2nd National Research Coordinators Meeting (Oslo) reviewed and finalized field test instruments- items and questionnaires |
| October 2006 | TIMSS & PIRLS International Study Center distributed final field test instruments to the National Research Coordinators |
| October 2006 | TIMSS & PIRLS International Study Center conducted a Pilot test of constructed-response items in several countries to collect sample responses for the constructed-response items. |
| November 2006 | Task Force met (Boston) to finalized scoring guides for constructed-response items and develop scoring training materials for the 3rd NRC Meeting |
| February 2007 | 3rd National Research Coordinators Meeting (Rome) conducted field test scoring training |
| February–March 2007 | TIMSS Advanced 2008 field test administered |
| May 2007 | TIMSS & PIRLS International Study Center reviewed the field test item statistics to propose the assessment items for review at the 4th NRC Meeting |
| June 2007 | 4th National Research Coordinators Meeting (Lubeck) reviewed and approved items and questionnaires for the TIMSS Advanced 2008 assessment |
| July 2007 | TIMSS & PIRLS International Study Center distributed the TIMSS Advanced 2008 Data Collection instruments to National Research Coordinators |
| September 2007 | Task Force met (Oslo) to review and finalize scoring guides and scoring training materials for the 4th NRC Meeting Reviewed and refined the proposed curriculum questionnaires |
| January 2008 | 5th National Research Coordinators Meeting (Portoroz) conducted scoring training for constructed-response items |
| February–May 2008 | TIMSS Advanced 2008 data collection |

2.2 Assessment Frameworks

The *TIMSS Advanced 2008 Assessment Frameworks* (Garden, R.A., Lie, S., Robitaille, D.F., Angell, C, Martin, M.O., Mullis, I.V. S., Foy, P., & Arora, A., 2006) contains a detailed description of the TIMSS Advanced 2008 assessment in advanced mathematics and physics. The

basic structure of each of the frameworks has two dimensions: content and cognitive domain. The content domains specify the subject matter to be assessed within each subject, and the cognitive domains describe the thinking processes to be assessed.

Advanced mathematics has three content domains or areas: algebra, calculus, and geometry. Physics has four content domains: mechanics, electricity, heat and temperature, and atomic and nuclear physics. For both subjects, the cognitive domains are the same. There are three cognitive domains: knowing, applying, and reasoning. Exhibits 2.2 and 2.3 show the target percentages for advanced mathematics and physics devoted to the content and the cognitive domains, as described in the framework.

Exhibit 2.2 Target Percentages for the TIMSS Advanced Mathematics Assessment Devoted to Content and Cognitive Domains

| Content Domains | Percentages |
|-----------------|-------------|
| Algebra | 35% |
| Calculus | 35% |
| Geometry | 30% |

| Cognitive Domains | Percentages |
|-------------------|-------------|
| Knowing | 35% |
| Applying | 35% |
| Reasoning | 30% |

Exhibit 2.3 Target Percentages for the TIMSS Advanced 2008 Physics Assessment Devoted to Content and Cognitive Domains

| Content Domains | Percentages |
|----------------------------|-------------|
| Mechanics | 30% |
| Electricity and Magnetism | 30% |
| Heat and Temperature | 20% |
| Atomic and Nuclear Physics | 20% |

| Cognitive Domains | Percentages |
|-------------------|-------------|
| Knowing | 30% |
| Applying | 40% |
| Reasoning | 30% |

2.3 Number of Items

The TIMSS Advanced 2008 assessment design is described in the *TIMSS Advanced 2008 Assessment Frameworks*. In brief, the assessment consists of 14 item blocks. Out of the total of 14 blocks, 6 blocks consist of trend items (items that were used in 1995 assessment), and 8 blocks consist of items newly developed for the 2008 assessment. These 14 blocks were distributed across 8 booklets. The design was chosen to ensure that each student responded to a sufficient number of items to provide a reliable measure, as well as to ensure that the trends across content and cognitive domains were reliably measured. Based on the design, a total of 72 advanced mathematics and 71 physics items were included in the assessment.

2.4 Developing Advanced Mathematics and Physics Items and Scoring Guides

Developing the replacement items for the TIMSS Advanced 2008 assessment was a collaborative effort of participating institutions. The development work on the items began in March 2006, immediately

after the draft framework was posted for the NRCs review. In May 2006, the first NRC meeting to review the item pool was held. There were 181 advanced mathematics items and 80 physics items to review at this meeting, developed mostly by the international subject coordinators. Norway, Russia, and Slovenia also contributed items to the item pool. During the meeting, participants gave suggestions for revising some of the items, and a few items were rejected. From June 2006 to August 2006, the item development work continued. More new items were developed by Sweden and Norway, and items also were developed by physics experts in Australia and mathematics experts in Bulgaria. In September 2006, new items were developed to cover those areas in the framework for which there were few items. Approximately 125 advanced mathematics and 110 physics items were presented for the discussion at the second NRC meeting in September. As a result of the review during the NRC meeting, 90 items for each subject were selected for the field test.

Each constructed-response question was developed with a scoring guide. Constructed-response items generally were worth 1 or 2 score points, depending on the nature of the task or skills required to complete it. Constructed-response items worth 1 score point typically require a numerical response or a brief descriptive response, while those worth 2 score points require students to show their work or provide explanations using words and/or diagrams to demonstrate their conceptual understanding.

2.5 Conducting the TIMSS Advanced 2008 Field Test

Newly developed items for the TIMSS Advanced 2008 assessment were field tested in February–March 2007. Eight countries participated in the field test. Approximately twice the number of items were field tested as were needed for the data collection. For each subject, 90

items were assembled into nine blocks, and placed into three booklets. Typically countries sampled between 18–28 schools and approximately 500 students.

The field test provided information for evaluating the measurement properties of the new items developed for this assessment.

2.6 Piloting Items for the Scoring Guides

The TIMSS Advanced 2008 constructed-response items elicit a wide range of responses from students. It is very important to score these responses consistently across countries and languages. This requires extensive training in applying the scoring guides. For training purposes, a pilot test was conducted to obtain students' responses for a selected set of constructed response items. The TIMSS Advanced 2008 pilot test contained 15 items for each subject. It was conducted in September–October 2006. At that time, Australia, Serbia, Armenia, the Netherlands, and Norway conducted the pilot test. Responses from non-English-speaking countries were translated into English before they were used as example responses. Participating countries conducted the pilot test in either one or two classes.

2.7 Field Test Scoring Training for Constructed-response Items

In preparation for the field test scoring training meeting, the task force met to prepare the NRC training materials. Task force members first reviewed each scoring guide to determine whether all types of responses were covered in the response categories mentioned in the guide and also whether all the categories were mutually exclusive. Then, they reviewed the responses collected during the pilot test, and selected 8–12 examples and 8–12 practice responses for the example items that members considered elicited varied range of responses. These responses

were included in the training binder that was prepared for the scoring training meeting.

The TIMSS & PIRLS International Study Center conducted the constructed-response scoring training meeting in February 2007 for NRCs and their scoring managers who implemented the constructed-response scoring in their respective countries.

2.8 Item Selection for Data Collection

The selection of items for data collection was based on results from the field test. After the field test, the countries sent the data files to the IEA Data Processing and Research Center (DPC) for cleaning and verification. After verifying and transforming data into the international format, the IEA DPC sent the data to the TIMSS & PIRLS International Study Center. The TIMSS & PIRLS International Study Center then prepared data almanacs for review and presented the results of all items that were field tested. Two sets of almanacs were produced for each subject. The first set gave an overall picture of the item. For each item, the difficulty, discrimination, and reliability indices were displayed. Additionally, for multiple-choice items, the almanacs also included information on how many students chose the particular response option. Also, for constructed response items what percentage of student received 0, 1 or 2 scores was displayed. The second set of almanacs, showed for each participating country, the percent of students who chose a specific response option. These almanacs were the bases of evaluating the performance and quality of the achievement items and making suggestions for revisions for the data collection.

For each item, the results were reviewed in the light of the difficulty of the item, how well the item discriminated between high- and low-

achieving students, the effectiveness of the alternatives, and the scoring reliability for the constructed-response items.

First, in May 2007, the TIMSS & PIRLS International Study Center staff and the mathematics and physics coordinators reviewed data from the field test. The items were categorized into “proposed” and “alternate” items. The proposed items were then reviewed by the NRCs at the fourth NRC meeting held in June 2007. During the review process, some proposed items were replaced by alternate items, and some minor changes were made to a few of the proposed items.

Finally, 90 items were selected, 45 for each subject from the pool of 180 items that had been field tested. These newly developed items, together with the trend items from 1995, form the TIMSS Advanced 2008 assessment. The trend items were also mapped into content and cognitive categories described in the TIMSS Advanced 2008 frameworks.¹

Mathematics Assessment

Exhibit 2.4 shows the distribution of new and trend items in the TIMSS Advanced 2008 mathematics test by content and cognitive domains. Additionally, this exhibit also includes information about item formats.

¹ Four items in mathematics and two items in physics could not be classified according to the new categories. These six items were not included in Exhibits 2.4 through 2.9

Exhibit 2.4 Advanced Mathematics Items by Content and Cognitive Domains and Item Format

| Content Domain | Trend Items in 2008 Assessment | New Items in 2008 Assessment | All Items in 2008 Assessment | Multiple-Choice Items in 2008 Assessment | Constructed-Response Items in 2008 Assessment |
|----------------|--------------------------------|------------------------------|------------------------------|--|---|
| Algebra | 10 | 16 | 26 | 17 | 9 |
| Calculus | 7 | 18 | 25 | 13 | 12 |
| Geometry | 10 | 11 | 21 | 16 | 5 |
| Total | 27 | 45 | 72 | 46 | 26 |

| Cognitive Domain | Trend Items in 2008 Assessment | New Items in 2008 Assessment | All Items in 2008 Assessment | Multiple-Choice Items in 2008 Assessment | Constructed-Response Items in 2008 Assessment |
|------------------|--------------------------------|------------------------------|------------------------------|--|---|
| Knowing | 14 | 14 | 28 | 21 | 7 |
| Applying | 8 | 19 | 27 | 14 | 13 |
| Reasoning | 5 | 12 | 27 | 11 | 6 |
| Total | 27 | 45 | 72 | 46 | 26 |

Exhibit 2.5 shows the score point distribution for the mathematics assessment by content and cognitive domains. The target percentages for content domains, described in the framework, were met within an acceptable difference (2%). For the cognitive domains, the percentage of items assessing reasoning was a little less than desired (4%) and consequently the percentage of knowing and applying were somewhat higher.

Exhibit 2.5 Distribution of Score Points in the Advanced Mathematics Assessment by Content and Cognitive Domains

| Content Domain | Cognitive Domain | | | Total Score Points | Percentage of Score Points |
|-----------------------------------|------------------|------------|------------|--------------------|----------------------------|
| | Knowing | Applying | Reasoning | | |
| Algebra | 12 | 11 | 7 | 30 | 37% |
| Calculus | 13 | 8 | 8 | 29 | 35% |
| Geometry | 5 | 12 | 6 | 23 | 28% |
| Total Score Points | 30 | 31 | 21 | 82 | |
| Percentage of Score Points | 37% | 38% | 26% | | |

The number of score points across the content domains for each booklet is shown in Exhibit 2.6. The number of score points per booklet varied from 36 to 38 points, except in booklet 1. Booklet 1 composed only of trend blocks had 30 points.

Exhibit 2.6 Number of Score Points in the Advanced 2008 Mathematics Booklets by Content Domain

| Content Domain | Booklet | | | |
|-----------------------------|-----------|-----------|-----------|-----------|
| | 1 | 2 | 3 | 4 |
| Algebra | 12 | 15 | 12 | 14 |
| Calculus | 7 | 13 | 15 | 12 |
| Geometry | 11 | 9 | 11 | 10 |
| Total in Mathematics | 30 | 37 | 38 | 36 |

Physics Assessment

Exhibit 2.7 shows the distribution of new and trend items in the TIMSS Advanced 2008 physics test by content and cognitive domains. Additionally, this exhibit also includes information about item formats.

Exhibit 2.7 Physics Items by Content and Cognitive Domains and Item Format

| Content Domain | Trend Items In 2008 Assessment | New Items in 2008 Assessment | All Items in 2008 Assessment | Multiple-Choice Items in 2008 Assessment | Constructed-Response Items in 2008 Assessment |
|----------------------------|--------------------------------|------------------------------|------------------------------|--|---|
| Mechanics | 9 | 11 | 20 | 11 | 9 |
| Electricity and Magnetism | 8 | 13 | 21 | 13 | 8 |
| Heat and Temperature | 2 | 13 | 15 | 7 | 8 |
| Atomic and Nuclear Physics | 7 | 8 | 15 | 11 | 4 |
| Total | 26 | 45 | 71 | 42 | 29 |

| Cognitive Domain | Trend Items In 2008 Assessment | New Items in 2008 Assessment | All Items in 2008 Assessment | Multiple-Choice Items in 2008 Assessment | Constructed-Response Items in 2008 Assessment |
|------------------|--------------------------------|------------------------------|------------------------------|--|---|
| Knowing | 3 | 15 | 18 | 12 | 6 |
| Applying | 15 | 21 | 36 | 25 | 11 |
| Reasoning | 8 | 9 | 17 | 5 | 12 |
| Total | 26 | 45 | 71 | 42 | 29 |

Exhibit 2.8 shows the score point distribution for the physics assessment by content and cognitive domains. Mostly, the target percentages described in the framework were met within the acceptable difference. The percentage of items assessing knowing was less and applying was more than desired.

Exhibit 2.8 Distribution of Score Points in the Physics Assessment by Content and Cognitive Domains

| Content Domain | Cognitive Domain | | | Total Score Points | Percentage of Score Points |
|-----------------------------------|------------------|------------|------------|--------------------|----------------------------|
| | Knowing | Applying | Reasoning | | |
| Mechanics | 4 | 11 | 9 | 24 | 29% |
| Electricity and Magnetism | 5 | 12 | 7 | 24 | 29% |
| Heat and Temperature | 4 | 10 | 6 | 20 | 24% |
| Atomic and Nuclear Physics | 5 | 8 | 3 | 16 | 19% |
| Total Score Points | 18 | 41 | 25 | 84 | |
| Percentage of Score Points | 21% | 49% | 30% | | |

Exhibit 2.9 shows the number of score points in each of the four physics booklets by content domain. The total number of items per booklet ranged from 31–38 across the four booklets.

Exhibit 2.9 Number of Score Points in the Physics Booklets by Content Domain

| Content Domain | Booklet | | | |
|----------------------------|-----------|-----------|-----------|-----------|
| | 5 | 6 | 7 | 8 |
| Mechanics | 10 | 9 | 10 | 10 |
| Electricity and Magnetism | 10 | 12 | 11 | 8 |
| Heat and Temperature | 3 | 12 | 8 | 10 |
| Atomic and Nuclear Physics | 8 | 5 | 6 | 8 |
| Total in Physics | 31 | 38 | 35 | 36 |

2.9 Finalizing the Scoring Guides for Constructed-response Items

In September 2007, the TIMSS Advanced Task Force met to review and revise the constructed-response scoring guides and training materials. Based on the field test, some response categories were deleted and some categories were revised. There also were adjustments in the trend scoring guides to align them with the scoring guides for the new items. Also, some response categories that were used in 1995 were collapsed to decrease the scoring burden of the scorers and increase scoring reliability.

The training materials for the 55 constructed-response items were arranged by assessment block, unlike the field test which was arranged by the booklets. Training materials included 6–15 example responses and 6–15 practice responses for each of the constructed-response items. During the 5th NRC meeting, NRCs and their scoring managers were given extensive training on how to use these materials in their countries. Discussions in the training session led to further refinements of some categories in the scoring guides. After the meeting, those revisions were made, and the final versions of the scoring guides were made available to the NRCs in February 2008.

2.10 Developing the TIMSS Advanced 2008 Background Questionnaires

TIMSS Advanced 2008 collected information about key factors related to student's home and school environments. In order to collect this information, TIMSS Advanced 2008 administered questionnaires to NRCs, school principals, teachers, and students. These questionnaires are described in detail in the next section (2.11). However, in brief:

- ◆ The *Curriculum Questionnaires* for advanced mathematics and physics were completed by NRCs. Newly developed for 2008, these

questionnaires collected information about the organization of the advanced mathematics curriculum and the physics curriculum.

- ◆ The *School Questionnaire* asked school principals to provide information about the school contexts and the resources available for advanced mathematics and physics instruction.
- ◆ The *Teacher Questionnaires*, one for mathematics teachers and the other one for physics teachers, gathered information about teachers' background as well as the structure and content of instruction in the classroom.
- ◆ The *Student Questionnaires*, one for advanced mathematics and one for physics, collected information about students' background, their home, experience in and out of school, their attitudes, and the resources available at home and in school for learning.

Developing the TIMSS Advanced 2008 background questionnaires was a collaborative effort between the TIMSS & PIRLS International Study Center and the NRCs of the participating countries.

The development work began in August of 2006 with staff at the TIMSS & PIRLS International Study Center reviewing TIMSS 1995 questionnaires for the advanced populations of students in the final years of secondary school and TIMSS 2007 questionnaires. Based on these two different sets of questionnaires, a set of TIMSS Advanced 2008 questionnaires was drafted with items collecting important information on the contexts of teaching and learning for this particular population of students.

These draft questionnaires were presented at the 2nd NRC meeting in September 2006. NRCs reviewed the draft questionnaires and gave suggestions for improvements. There were some questions that were revised, and some new questions were added. The revised questionnaires were formatted for the field test and distributed to

NRCs, along with the filed test achievement booklets in October 2006.² The questionnaires were field tested in February–March of 2007.

After the field test, the countries sent the data files to the IEA Data Processing and Research Center (DPC) for cleaning and verification. After verifying and transforming data into the international format, the IEA DPC forwarded the data to the TIMSS & PIRLS International Study Center. The TIMSS & PIRLS International Study Center then prepared data almanacs of the field test results of all questionnaires. For every participating country, each almanac displayed student-weighted distributions of responses for each item in the questionnaires. For categorical variables, the weighted percentage of respondents choosing each option was shown, together with the corresponding average student achievement in advanced mathematics or physics. For questions with numeric responses, mean, mode, and selected percentiles were given. These almanacs were used to evaluate the performance and quality of the field test questionnaire items.

The review of the field test data almanacs was completed at the 4th NRC meeting in June 2007. The group examined the item statistics and some items were deleted. In a few instances, the language was clarified. Following the meeting, the TIMSS & PIRLS International Study Center updated the questionnaires. The final questionnaires were made available to the NRCs in July 2007 so countries could begin the translation and verification process.³

Because the NRCs from the 10 countries were responsible for completing the curriculum questionnaires, they did not need to be field tested. Work begun in August 2007, with TIMSS & PIRLS International Study Center staff drafting curriculum questionnaires based on *TIMSS 2007 Curriculum Questionnaires*. These drafts were first discussed with task force members during the September 2007 meeting. During this meeting, some of the existing questions were modified or rejected, and

2 The curriculum questionnaires were not distributed at this stage.

3 The translation and verification process is described in detail in Chapter 3.

new questions were added. In October, the revisions were made to the draft questionnaires based on feedback from the task force meeting. These revised questionnaires were discussed during the fifth NRC meeting in January 2008. During this meeting, more revisions were made. The final curriculum questionnaires were distributed to NRCs in February 2008.

2.11 Content of the Background Questionnaires

The content of each TIMSS Advanced 2008 questionnaire is summarized below. Exhibits 2.10 through 2.13 provide descriptions of the variables within each questionnaire. The variables in each questionnaire are grouped according to their contextual factors.

Curriculum Questionnaires

The NRCs were responsible for completing the curriculum questionnaires. The curriculum questionnaires were designed to collect basic information about the organization, content, and implementation of the intended mathematics and physics curriculum in each country. The questionnaires also contained questions about requirements for teachers.

The two versions of the curriculum questionnaires for advanced mathematics and physics, respectively, were parallel in structure and very similar in content, with slight modifications made to accommodate the subject-specific content.

School Questionnaire

The principal of each sampled school for TIMSS Advanced 2008 completed a school questionnaire. The questionnaire was designed to collect information about the school's demographic characteristics, resources for teaching, and the school environment. Principals also answered questions about their role as an administrator.

Teacher Questionnaires

Teachers of the assessed mathematics and physics classes responded to the corresponding teacher questionnaire for advanced mathematics or physics. The questionnaires were designed to gather information about the classroom contexts of teaching and learning. Teachers also answered questions about their professional preparation and experience in teaching.

The general structure of the two questionnaires was the same. However, questions pertaining to instructional and assessment practices and content coverage were tailored to the specific subject.

Student Questionnaire

Each student participating in the study completed the appropriate advanced mathematics or physics student questionnaire. The student questionnaires were designed to gather information on some of the major factors that influence student achievement in the areas of advanced mathematics and physics. The questionnaire included questions about the home background and resources for learning, attitudes about advanced mathematics and physics, and experiences in learning these subjects. Once again, the two questionnaires—for advanced mathematics and physics students were similar. However, when necessary, the subject-specific content was tailored to the specific subject.

Exhibit 2.10 Content of TIMSS Advanced Curriculum Questionnaire

| Items | | Context | Variables |
|-------------|---------|--------------------------------|---|
| Mathematics | Physics | | |
| 1 | 1 | Curriculum characteristics | Year the curriculum was implemented |
| | | | Whether the curriculum is being revised |
| 6 | 6 | | Forms in which the curriculum is made available |
| 8 | 8 | | Total amount of class time prescribed by the curriculum for students in the track assessed |
| 7 | 7 | Governance of education system | Whether textbooks used in the track or course assessed were certified by an education authority |
| | | | Who is responsible for cost of textbooks |
| 8 | 8 | | Whether the country has national requirement on the number of school days per year for the track or course being assessed |
| 13 | 13 | | Whether the national education authority administers any examinations that have consequences for individual students |
| 2 | 2 | Curriculum Policy | Whether the curriculum has prerequisite courses or tracks for students |
| | | | Percentage of students fulfilling the prerequisites |
| | | | Whether taking the mathematics/physics track or course is a prerequisite for further study |
| 4 | 4 | | Whether the national curriculum addresses the use of computers in the track or course being assessed |
| 5 | 5 | | Whether TIMSS Advanced mathematics/physics topics are included in the curriculum over the course of the year |
| 9 | 9 | | Whether there is an official policy to encourage students to choose advanced courses |
| 12 | 12 | | Methods used to evaluate the implementation of the curriculum |
| 3 | 3 | Emphasis on calculator use | Whether the curriculum for students being assessed addresses the use of calculators |
| | | | Whether the curriculum specifies the type of calculators that may be used |
| | | | Whether the curriculum permits use of calculators in national examinations |
| | | | Who pays for the cost of calculators |
| 10 | 10 | Teacher preparations | National requirements for a teacher of the track or course being assessed |
| 11 | 11 | | Methods used to communicate changes about the curriculum to teachers |

Exhibit 2.11 Content of TIMSS Advanced School Questionnaire

| Context | Item | Variables |
|--------------------------|-------|---|
| School Characteristics | 1 | Number of students enrolled in the school and grade tested |
| | 2 | Size of community in which school is located |
| | 3 | Percentage of students in the school from economically affluent and disadvantaged homes |
| | 4 | Percentage of students whose native language is the language of the test |
| | 5 | Percentage of students taking the TIMSS Advanced 2008 tests |
| School Policy | 6 | Whether the school had a policy encouraging students to take courses in mathematics and physics |
| | 9/10- | Whether mathematics/physics teachers' practices were evaluated by the principal or senior staff, level of student achievement, etc. |
| | 12 | Whether the school uses incentives to recruit or retain teachers |
| School Climate | 7 | Principal's time allocation for different tasks and functions |
| | 8 | Principal's perception of different aspects of school climate |
| | 11 | Difficulties of filling teaching vacancies |
| | 13 | Principal's perception of the frequency and severity of different problems within the school |
| Resources and Technology | 14 | Material factors affecting school's capacity to provide instruction |
| | 15 | Whether a physics laboratory and assistance was provided for students' experiments |
| | 16 | Whether school had support in helping teachers use information and communication technology for teaching and learning |
| | 17 | Number of computers and internet available for educational purposes |

Exhibit 2.12 Content of the TIMSS Advanced Teacher Questionnaire

| Item number | | Context | Variables |
|-------------|---------|--|--|
| Mathematics | Physics | | |
| 1 | 1 | Teacher Demographics | Age |
| 2 | 2 | | Gender |
| 3 | 3 | | Total number of years teaching and number of years teaching advanced mathematics/physics |
| 4 | 4 | | Expected time to continue teaching advanced mathematics/physics |
| 5 | 5 | | Teacher's highest level of formal education |
| 6 | 6 | | Teacher's major areas of study during post-secondary education |
| 7 | 7 | Teacher Training and Preparation | Whether the teacher has a license or certificate |
| 8 | 8 | | How ready the teacher feels to teach the topics included in the TIMSS Advanced mathematics/physics test |
| 9 | 9 | | Frequency of various types of interactions the teacher has with colleagues |
| 10 | 10 | | Whether the teacher is a member of professional organization |
| 11 | 11 | | Whether the teacher has regularly participated in professional organization activities over the past two years |
| 12 | 12 | | Whether the teacher has participated in various professional development activities over the past two years |
| 13 | 13 | School Environment and Structure | Teacher's perception about the school's safety |
| 14 | 14 | | Teacher's perception about the school's facilities |
| 15 | 15 | | Teacher's perception of teachers' job satisfaction, understanding of and success in school's curriculum, and expectations for student achievement; of parental support and involvement; and of students' regard for school property, and desire to do well in school |
| 16 | 16 | Class Characteristics and Climate | Number of students in TIMSS class |
| 22 | 22 | | Extent to which the teacher perceives various student and resource factors as limiting teaching |
| 17 | 17 | | Minutes per week the teacher teaches advanced mathematics/physics to the TIMSS class |
| 18 | 18 | | Minutes per week the teacher spends on preparation for teaching the TIMSS class |
| 20 | 20 | | Percentage of time in a week spent on various teaching activities in advanced mathematics/physics lessons |
| 21 | 21 | | Frequency with which the teacher asks students to do various learning activities in the TIMSS class |
| 23 | 23 | | Percentage of time spent on advanced mathematics/physics content areas over the course of the year |
| 19 | 19 | Instructional Materials and Technology | Whether a textbook is used as the basis of instruction |
| | | | Whether each student has his or her own textbook |
| | | | Frequency with which the teacher asks students to do various textbook-related activities in advanced mathematics/physics |
| 24 | 24 | | Coverage of topics in the advanced mathematics/physics content areas while teaching over the course of the year |
| 25 | 25 | | Frequency with which the teacher uses a computer to demonstrate advanced mathematics/physics |

Exhibit 2.12 Content of the TIMSS Advanced Teacher Questionnaire (Continued)

| Item number | | Context | Variables |
|-------------|---------|--|---|
| Mathematics | Physics | | |
| 26 | 26 | Instructional Materials and Technology | Whether students have access to calculators, computers or other computing technology in class |
| | | | Type of calculators majority students have access to in class |
| | | | Whether computers have access to internet |
| 27 | 27 | | Frequency with which the students use calculators or computers for various learning activities |
| 28 | 28 | Homework and Assessment | Whether the teacher assigns advanced mathematics/physics homework to the TIMSS class |
| 29 | 29 | | Frequency with which the teacher assigns mathematics/physics homework to the TIMSS class |
| 30 | 30 | | Number of minutes taken by an average student to complete an advanced mathematics/physics homework assignment |
| 31 | 31 | | Frequency with which the teacher assigns various types of homework |
| 32 | 32 | | Emphasis the teacher places on various sources to monitor students' progress |
| 33 | 33 | | Frequency with which the teacher gives a test or examination |
| 34 | 34 | | Item formats the teacher typically uses in tests or examinations |
| 35 | 35 | | Types of questions the teacher includes in tests or examinations |

Exhibit 2.13 Content of the TIMSS Advanced Student Questionnaire

| Item number | | Context | Variables |
|-------------|---------|--|---|
| Mathematics | Physics | | |
| 1 | 1 | Student Characteristics | Year and month of student's birth |
| 2 | 2 | | Gender |
| 3 | 3 | | Student's frequency of use of the language of test at home |
| 7 | 7 | | Whether the student's mother and father were born in country |
| 8 | 8 | | Whether the student was born in country, and, if not, age at which the student emigrated |
| 4 | 4 | Economic and Educational Resources in the Home | Number of books in the student's home |
| 5 | 5 | | Educational resources and general possessions in the student's home |
| 6 | 6 | | Highest education level completed by the student's mother and father |
| 20 | 20 | | Frequency of tutoring in advanced mathematics/physics |
| 9 | 9 | Student Attitudes | Whether the student intends to continue his or her education after secondary school |
| 10 | 10 | | Subject that the student intends to study if he or she plans to continue education |
| 13 | 13 | | Reasons why the student is taking advanced mathematics/physics |
| 11 | 11 | Computer/Calculator Activities | Average time in a day spent on a computer by the student |
| | | | Frequency with which the student uses a computer in various places |
| | | | Whether the student uses a computer for various learning activities |
| 17 | 17 | | Frequency with which the student uses a calculator, computer or other computing technology in advanced mathematics/physics lessons |
| | | | Type of calculator the student uses in advanced mathematics/physics lessons |
| 19 | 19 | | Frequency with which the student uses a computer for work on advanced mathematics/physics outside of class |
| 12 | 12 | Activities in School | Average time in a normal school day the student spends on various activities before or after school |
| 14 | 14 | | Minutes per week the student spends in advanced mathematics/physics class |
| | | | Whether the advanced mathematics student is taking or has taken the physics track/course and Whether the physics student is taking or has taken the advanced mathematics track/course |
| 15 | 15 | | Frequency with which the student uses various learning methods in advanced mathematics/physics lessons |
| 16 | 16 | | Frequency with which the student engages in various learning activities in advanced mathematics/physics lessons |
| 18 | 18 | Homework and Assessment | Minutes per week the student spends doing advanced mathematics/physics homework |
| | | | Frequency with which the student does various activities for doing homework |
| 21 | 21 | | Frequency with which the student prepares for a test or examination in advanced mathematics/physics |

References

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

