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This chapter documents the development of the TIMSS international reports for the primary and middle school years (third, fourth, seventh, and eighth grades in most countries) and analysis and reporting of the background questionnaire data.¹ In particular, it provides an overview of the consensus process used to develop the report outlines and table prototypes; describes special considerations in reporting the student and teacher background data; and explains how TIMSS handled issues of non-response in reporting these data.

11.1 CONTEXT QUESTIONNAIRES

TIMSS administered questionnaires to students, their mathematics and science teachers, and the principals of their schools to gather contextual information related to the teaching and learning of mathematics and science. Table 11.1 lists the background questionnaires administered at each population.

Table 11.1 TIMSS Background Questionnaires

| Population 1 | Population 2 |
|-----------------------|--|
| Student Questionnaire | Student Questionnaire (nonspecialized) |
| School Questionnaire | Student Questionnaire (specialized) |
| Teacher Questionnaire | School Questionnaire |
| | Teacher Questionnaire (Mathematics) |
| | Teacher Questionnaire (Science) |

Students in Populations 1 and 2 completed questions about their attitudes towards mathematics and science, home background, out-of-school activities, and classroom activities and experiences. At Population 2 there were two versions of the student questionnaires; one version was intended for systems where science is taught as an integrated subject and the other for systems where science is taught as separate subjects (biology, chemistry, earth science, and physics). These are referred to as the nonspecialized and specialized versions, respectively. Although these two versions of the questionnaire differed with respect to the science questions, the general background and mathematics-related questions were identical across the two forms. In the nonspecialized version, science-related questions pertaining to students' attitudes and classroom activities are based on single questions asking about "general or integrated

¹ Reporting of background questionnaire data for the assessment of students in their final year of secondary school will be described in the forthcoming *TIMSS Technical Report, Volume III*.

science,” while in the specialized version a series of questions is asked about each of the separate science subject areas. This structure accommodated the diverse systems that participated in TIMSS but did pose challenges in reporting the data, as is further described later in this chapter.

Teachers of students in the lower and upper grades of Populations 1 and 2 answered questions about their education, instructional practices, classroom organization, and views on mathematics and science education. At Population 2, there were two versions of the teacher questionnaire, one for mathematics teachers and one for science teachers. Although the general background questions were the same for the two versions, questions pertaining to instructional practices, content coverage, classroom organization, and views of subject matter were geared towards mathematics or science. At Population 1, there was only one version of the questionnaire. It included general background questions and questions related to mathematics and science instruction. Section 11.5.1 of this chapter discusses the complications that arose from having one teacher questionnaire for Population 1 and how those complications were handled in the analysis and reporting.

The school questionnaire included questions regarding school characteristics and policies, resources, and course offerings.

The development of these questionnaires and the variables included in each instrument are described in Schmidt and Cogan (1996).

11.2 TIMSS REPORTING APPROACH

The TIMSS results were reported separately by grade. Because every country participated in Population 2, the core of TIMSS, the International Study Center published the results for the lower and upper grades of Population 2 (seventh and eighth grades) first, followed by the results for the lower and upper grades of Population 1 (third and fourth grades) and Population 3 (final year of secondary school). The mathematics results and science results were published in separate volumes.

Background data were reported for the students in the upper grade of the target populations only (fourth and eighth grades in most countries), but not for those in the lower grade for several reasons. First, reporting data for both grades in a population would have doubled the size of the report or limited the number of variables that could be reported. It was therefore decided that in order to present as wide a range of information as possible, data would be reported for only one grade of the target population, but would address as many issues as possible. In addition, more questions in the context questionnaires were geared towards the upper-grade students, particularly in the teacher questionnaire. Data for the lower grade of the target populations are available in the international database.

11.3 DEVELOPMENT OF THE INTERNATIONAL REPORTS

The International Study Center's initial plans for reporting the background data were based on the TIMSS conceptual model, and on research questions developed early in the study and used as the basis for instrument development. The documentation on the TIMSS conceptual model developed by the Survey of Mathematics and Science Opportunity (SMSO) project at Michigan State University, and the various documents presenting alternative reporting and analysis plans that had been written during the years of the study, were reviewed and used as the basis for the initial round of outlines for the international reports. These documents included:

- *TIMSS: Concepts, Measurements, and Analyses, Abbreviated Version* (Schmidt, 1993)
- *TIMSS Educational Opportunity Model: Detailed Instrumentation and Indices Development* (Schmidt, 1994)
- *TIMSS Monograph No. 1: Curriculum Frameworks for Mathematics and Science* (Robitaille et al., 1993)
- *TIMSS Monograph No. 2: TIMSS Research Design* (Robitaille and Garden, 1996)
- *TIMSS Analysis Plan IV: The First U.S. TIMSS Reports* (Williams, 1995).
- *Research Questions for TIMSS – Draft* (Robitaille and Nicol, 1993)
- *TIMSS ICC Publications Plan – Draft* (Robitaille, 1993)

In addition, reports of previous IEA studies and the research literature were used as a basis for the initial outlines.

As described in Schmidt and Cogan (1996), TIMSS was designed to investigate student learning of mathematics and science and the way in which education systems, schools, teachers, and the students themselves all influence the learning opportunities and experiences of individual students. This explanatory framework offers four major research questions used to undergird the development of the data collection instruments: What are students expected to learn? Who delivers instruction? How is instruction organized? What have students learned?

In attempting to address the influences on student learning put forth by the model as key determinants of achievement – the system, schools, teachers, and students – the TIMSS International Study Center included in the initial report outlines as much information as possible about these aspects of the education system. In particular, the major areas included were the following:

- The curricular context of students' learning
- Students' characteristics and attitudes towards mathematics and science

- System-level characteristics
- School characteristics
- Teacher qualifications and characteristics
- Instructional organization and activities.

Within each of these categories those aspects described in the model as key features of the educational process were included in the outlines as proposed subsections.

The goal of the international reports was to present as much descriptive data related to the TIMSS model as possible, without overburdening the reader, and taking into consideration the time and resources available to produce the reports. The intention was that these initial descriptive reports would provide the basis for more complex secondary analyses to be undertaken at a later date.

Towards this end, tables presenting descriptive data related to each feature (e.g., parents' education, instruction time) were planned and table prototypes prepared. This required a careful review of the questionnaires and detailed documentation of the variables and categories, recodes, and analyses to be undertaken. These plans were documented in analysis notes for each proposed table.

Drafts of the analysis plans, report outlines, and table prototypes reporting results for the upper and lower grades of Population 2 were developed by the International Study Center and underwent a lengthy review process involving the TIMSS Technical Advisory Committee, Subject Matter Advisory Committee, the International Steering Committee, and the NRCs. Through this review process, consensus was built among the constituents as to the reporting priorities for the first international reports, including which variables should be reported and how much information to include. The list of meetings during which the analysis plans, outlines, and tables prototypes were reviewed follows.

| | |
|------------------------|-----------------------------------|
| June 1995, Ottawa | Technical Advisory Committee |
| July 1995, Boston | Subject Matter Advisory Committee |
| August 1995, Vancouver | International Steering Committee |
| August 1995, Vancouver | National Research Coordinators |
| January 1996, Cyprus | National Research Coordinators |

Following each review meeting, the report outlines and table prototypes were modified to reflect the perspectives of the various committee members and NRCs.

After the data became available for analysis in the spring of 1996, the International Study Center conducted the analyses documented in the analysis notes. The tables with results and accompanying text underwent a review process similar to that conducted for the outlines and table prototypes, and as a result, some tables and figures

were modified and some were deleted from the report. For example, for some categorical variables, categories were modified to reflect the distribution of student responses. Also, it was not possible to report the data collected via the school questionnaire in the first international reports, mainly because many of the questions were asked in open-ended format and would have required more time to clean and prepare for analysis than was available. The school data are available in the TIMSS international database. NRCs had several opportunities to review the draft tables in the light of their national data and to provide feedback on the quality and consistency of the background data.

The draft reports (text and tables) were reviewed by the International Steering Committee and the NRCs at a meeting in Prague in August 1996. Further refinements were made to the tables following that meeting and final drafts were sent out for review in September 1996. This review resulted in several additional modifications to the interpretations and presentation of the data. The reports were published in November 1996 as *Mathematics Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study* (Beaton et al., 1996a) and *Science Achievement in the Middle School Years: IEA's Third International Mathematics and Science Study* (Beaton et al., 1996b).

The reports presenting results for the upper and lower grades of Population 1 were modeled for the most part on the Population 2 reports. Some modifications were made to reflect the issues relevant to the primary school years, and some tables that appeared in the middle school reports were not available for the primary school report because certain questions were not asked of the younger students or their teachers. As with the middle school reports, a series of meetings was held during which NRCs and TIMSS committee members had the opportunity to review the plans for the primary school reports. These reports were published in June 1997 as *Mathematics Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study* (Mullis et al., 1997) and *Science Achievement in the Primary School Years: IEA's Third International Mathematics and Science Study* (Martin et al., 1997).

11.4 REPORTING STUDENT BACKGROUND DATA

Reporting the data that students provided through the student questionnaire was fairly straightforward. Most of the tables in the international reports present percentages of students in each country responding to each category of each variable, together with the mean achievement (mathematics or science) of those students. Some tables present percentages or averages based on derived variables. *The User Guide for the TIMSS International Database, Supplement 4* (Gonzalez and Smith, 1997) documents all derived variables that were published in the TIMSS international reports and included in the database. In general, jackknife standard errors accompany the statistics reported. (See Chapter 5 of this volume for a description of the methodology and additional references.)

While reporting of the general background and mathematics-related variables was also straightforward, reporting of the student responses to questions about their attitudes and self-perceptions related to science was more complicated. As described earlier in this chapter, for the two grades at Population 2 countries could administer a

student questionnaire that accommodated the manner in which science instruction is organized. One version of the questionnaire asked questions about science as an integrated subject (nonspecialized version); the other version asked questions about science taught as separate subject areas (specialized version). That countries administered different questionnaires posed a challenge for the international data processing and for the analysis. Moreover, the tables reporting those variables for which countries administered different versions had to present both types of data. As a result, those tables have a column where data are reported for the countries that administered the nonspecialized student questionnaire and a section where data are reported for the countries that administered the specialized student questionnaire.

In the tables and figures in the international report, countries that administered the nonspecialized version are included in the column reporting students' responses based on integrated science, while countries that administered the specialized version are included in the columns displaying students' responses based on separate science subject areas. Based on the form of the majority of science-related questions, 18 countries administered the specialized version and 22 countries the nonspecialized version of the student questionnaire (see Table 11.2). The classification of countries in Table 11.2 is based on whether the questions related to activities in science classes are based on integrated science classes or separate science subject areas.

Table 11.2 Countries Administering the Specialized and Nonspecialized Student Questionnaires - Population 2

| Nonspecialized Version (Science as an Integrated Subject) | Specialized Version (Science as Separate Subjects) |
|--|---|
| Australia | Belgium (Flemish) |
| Austria | Belgium (French) |
| Canada | Czech Republic |
| Colombia | Denmark |
| Cyprus | France |
| England | Germany |
| Hong Kong | Greece |
| Iran | Hungary |
| Ireland | Iceland |
| Israel | Latvia |
| Japan | Lithuania |
| Korea | Netherlands |
| Kuwait | Portugal |
| New Zealand | Romania |
| Norway | Russian Federation |
| Scotland | Slovak Republic |
| Singapore | Slovenia |
| Spain | Sweden |
| Switzerland | |
| Thailand | |
| United States | |

11.5 REPORTING TEACHER BACKGROUND DATA

Because the sampling for the teacher questionnaires was based on participating students, the responses to the teacher questionnaire do not necessarily represent all of the fourth- and eighth-grade teachers in each of the TIMSS countries. Rather, they represent teachers of the representative samples of students assessed. It is important to note that in the international reports, the student is always the unit of analysis, even when information from the teachers' questionnaires is being reported. Using the student as the unit of analysis makes it possible to describe the instruction received by representative samples of students. Although this approach may provide a different perspective from that obtained by simply collecting information from teachers, it is consistent with the TIMSS goals of providing information about the educational contexts and performance of students.

Another consequence of the TIMSS design, particularly at Population 2, was that since students were often taught mathematics or science by different teachers, and sometimes by more than one teacher (e.g., students were taking two or more mathematics classes or two or more science classes), they frequently needed to be linked to more

than one teacher. When a student was taught one or the other subject by more than one teacher, the student's sampling weight was distributed among the teachers that taught the student. In this way, the student's contribution to student population estimates remained constant regardless of the number of teachers he or she had. This was consistent with the policy of reporting attributes of teachers and their classrooms in terms of the percentages of students taught by teachers possessing these attributes.

11.5.1 Population 1 Teacher Data

In the two grades tested for Population 1 (third and fourth grades in most countries), students generally are taught mathematics and science by a single classroom teacher who provides instruction in all subjects. Accordingly, the international version of the teacher questionnaire for the primary grades was prepared as a single document asking about demographic information and instruction in both mathematics and science. Reporting data for these situations was straightforward in the sense that for one teacher the variables pertaining to mathematics instruction were included in the international mathematics report and the variables pertaining to science instruction were included in the science report. General background data for that teacher were included in both reports.

In some countries, however, a portion or even all of third- and fourth-grade students are taught mathematics and science by different teachers, and it was difficult to make provision for both teachers to complete the questionnaire. In these cases, one of the teachers was usually given the questionnaire and completed it as fully as possible, in most cases omitting those questions pertaining to the subject not taught to the class (i.e., if the teacher was a mathematics teacher he or she would omit most questions pertaining to science instruction and vice versa). Although an examination of which questions a teacher completed could have indicated which subject the teacher taught to the target class, TIMSS instead used data provided by the schools to determine whether a teacher taught mathematics, science, or both to the target class. Accordingly, all tables in the Population 1 international mathematics report (Mullis et al., 1997) that contain teacher data are based only on those teachers identified by schools as either mathematics teachers or mathematics and science teachers. Likewise, tables in the Population 1 international science report (Martin et al., 1997) that contain teacher data are based only on those teachers identified by schools as either science teachers or mathematics and science teachers. By identifying teachers as teaching the sampled students in mathematics, science, or both, TIMSS was able to report teacher background, instructional, and classroom variables and, where relevant, the relationship with achievement in mathematics or science.

Because countries were required to sample two classes (from adjacent grades) in each school, it was possible for an individual to be the mathematics and/or science teacher of both the upper- and lower-grade classes. In order to keep the response burden for teachers to a minimum, no teacher was asked to respond to more than one questionnaire, even where that teacher taught mathematics and/or science to more than one of the sampled classes. This had implications for response rates, as described in section 11.6.

11.5.2 Population 2 Teacher Data

In the two grades tested for Population 2 (seventh and eighth grades in most countries), students are generally taught mathematics and science by different teachers. Accordingly, there was a questionnaire for mathematics teachers and another for science teachers, each with the same general questions but with different subject-matter-related questions. Data collected from mathematics teachers were presented in the international mathematics report and those collected from science teachers in the corresponding science report. Where possible and relevant, the mean achievement of students was reported for each category in a table to show the relationship with achievement.

For each sampled student, his or her mathematics and science teachers were assigned a questionnaire. However, if a teacher taught sampled classes in both mathematics and science, then that teacher was randomly assigned either a mathematics or a science questionnaire. If a teacher taught either mathematics or science at both the lower and upper grade then that teacher was assigned a questionnaire for the upper-grade target class. The assignment of questionnaires to teachers of sampled students had implications for response rates; this is further explained in section 11.6.

As explained earlier, for students with more than one mathematics or science teacher the student weight was distributed among the teachers that taught the student (in that subject) so that the student's contribution to the population estimates remained constant regardless of the number of teachers.

11.6 REPORTING RESPONSE RATES FOR BACKGROUND QUESTIONNAIRE DATA

While it is desirable that all questions included in a data collection instrument be answered by all intended respondents, a certain percentage of nonresponse is inevitable. In addition to the problem of unanswered questions, sometimes entire questionnaires are not completed or not returned. In TIMSS, the teachers, students, or principals sometimes did not complete the questionnaire assigned to them or some questions within it, resulting in certain variables having less than a 100% response rate. The tables in the TIMSS international reports contain special notation regarding response rates for the background variables. The following section describes the types of nonresponse and how the variables with varying response rates are labeled in the TIMSS reports.

11.6.1 Teacher Data

Because teachers were asked to complete no more than one questionnaire even if they taught mathematics or science to more than one sampled class, and because teachers sometimes did not complete the questionnaire assigned to them, each country had some percentage of students for whom no teacher questionnaire information was available. The following special notation was used to convey information about response rates in tables in the international reports.

- For a country where teacher responses were available for 70% to 84% of the students, an “r” appears next to the data for that country.
- When teacher responses were available for 50% to 69% of the students, an “s” appears next to the data for that country.
- When teacher responses were available for fewer than 50% of the students, an “x” replaces the data.
- When the percentages of students in a particular category fell below 2%, achievement data were not reported in that category. The data were replaced by a tilde (~).

11.6.2 Student Data

Although in general there were high response rates for the student background variables, some variables and some countries exhibited less than acceptable response rates. The notation in the tables of the reports is similar to that for the teacher data.

- For a country where responses were available for 70% to 84% of the students, an “r” appears next to the data for that country.
- When responses were available for 50% to 69% of the students, an “s” appears next to the data for that country.
- When responses were available for fewer than 50% of the students, an “x” replaces the data.
- When the percentages of students in a particular category fell below 2%, achievement data were not reported in that category. The data were replaced by a tilde (~).

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