TEDS-M

The Teacher Education and Development Study in Mathematics (TEDS-M)

Policy, Practice, and Readiness to Teach Primary and Secondary Mathematics in 17 Countries

Technical Report

Edited by
Maria Teresa Tatto

IEA

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TEDS-M

This material is based on work supported by the National Science Foundation under Grant No. REC 0514431. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation (NSF).

ISBN/EAN: 978-90-79549-24-5

Copies of *The Teacher Education and Development Study in Mathematics (TEDS-M). Policy, Practice, and Readiness to Teach Primary and Secondary Mathematics in 17 Countries: Technical Report* can be obtained from:

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Copyedited by Paula Wagemaker Editorial Services, Oturehua, Central Otago, New Zealand
Design and production by Becky Bliss Design and Production, Wellington, New Zealand
Printed by MultiCopy Netherlands b.v.

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CHAPTER 1:

OVERVIEW OF THE TEACHER EDUCATION AND DEVELOPMENT STUDY IN MATHEMATICS

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The Teacher Education and Development Study in Mathematics (TEDS-M), conducted under the aegis of the International Association for the Evaluation of Educational Achievement (IEA), was designed to inform policy and practice in mathematics teacher education. For educational policymakers, TEDS-M contributes data on institutional arrangements that are effective in helping future teachers become sufficiently knowledgeable in mathematics and related teaching knowledge. For the teacher educators who design, implement, and evaluate teacher education curricula, TEDS-M contributes a shared terminology, a shared database, and benchmarks for examining their teacher education provision against what has proved possible and desirable to do in other settings. For mathematics teachers in schools, TEDS-M provides a better understanding of what qualified teachers of mathematics learn about the content and pedagogy of mathematics during their preservice education, as well as about the arrangements and conditions conducive to acquisition of this knowledge. For educators in general and for informed laypersons, TEDS-M provides a better understanding about what and how teachers learn as they prepare to teach.

Seventeen countries participated in TEDS-M.[1] They were Botswana, Canada (four provinces), Chile, Chinese Taipei, Georgia, Germany, Malaysia, Norway, Oman (lower-secondary teacher education only), the Philippines, Poland, the Russian Federation, Singapore, Spain (primary teacher education only), Switzerland (German-speaking cantons only), Thailand, and the USA (public institutions, concurrent and consecutive teacher education program routes only).

The TEDS-M joint-international research centers at Michigan State University (MSU) and the Australian Council for Educational Research (ACER) worked from 2006 to 2011 with the study's national research coordinators (NRCs) in the 17 countries to develop, implement, and report on the findings of this study. Funding for TEDS-M came from the collaborating countries, IEA, and the United States of America National Science Foundation. The TEDS-M framework is detailed in Tatto et al. (2008), and the study's findings can be found in the TEDS-M international report (Tatto et al., 2012). This technical report provides detailed information about the procedures developed and used during the study.[2] First, though, a brief account of the key features of the study is in order.

1 In the case of Canada, four distinct education systems (four provinces) participated in TEDS-M. The term "country" is used in this report to refer to both the countries and parts of countries that participated in the study.

2 This report provides another supporting document for researchers engaged in secondary analysis of the TEDS-M data. It should be used in conjunction with the *TEDS-M 2008 User Guide for the International Database* (Brese & Tatto, 2012).

1.1 Purpose of TEDS-M

TEDS-M was designed to explore not only how teachers are prepared to teach mathematics in primary and lower-secondary schools but also variation in the nature and impact of teacher education programs within and across countries. TEDS-M is the first crossnational study to provide data on the knowledge that future primary and lower-secondary school teachers acquire during their mathematics teacher education. Established with the express aim of providing information to inform policy and practice in teacher preparation, the study collected and analyzed data from representative national samples of preservice teacher education institutions (and the programs within them) as well as from their future primary and lower-secondary teachers and their teacher educators. The key research questions for the study focused on the relationships between teacher education policies, institutional practices, and future teachers' mathematics content knowledge and mathematics pedagogy content knowledge.

1.2 Research Questions

TEDS-M asked three key questions.

- *Question 1:* What are the policies that support primary and secondary teachers' achieved level and depth of mathematics and related teaching knowledge? This question concerned the policies directed at mathematics teachers, including recruitment, selection, preparation, and certification.
- *Question 2:* What learning opportunities available to prospective primary and lower-secondary mathematics teachers allow them to attain such knowledge? TEDS-M examined the intended and implemented curriculum of teacher education at the institutional level in each country, as well as the overall opportunities to learn embedded in this curriculum.
- *Question 3:* What level and depth of mathematics and related teaching knowledge have prospective primary and lower-secondary teachers attained by the end of their preservice teacher education? The study examined, in relation to this question, the intended and achieved goals of teacher education.

1.3 Data Sources

The first research question was addressed through individual case study country reports, questionnaires, and interviews issued by the TEDS-M international study centers. The second and third research questions were answered via surveys of nationally representative samples of

1. Teacher education institutions and programs;
2. Teacher educators;
3. Future primary school teachers preparing to teach mathematics; and
4. Future lower-secondary school teachers also preparing to teach mathematics.

The future teacher surveys included questions pertaining to respondents' backgrounds, opportunities to learn mathematics content and pedagogy, and beliefs about teaching and learning mathematics. The surveys also included a knowledge assessment of the mathematics content knowledge and the mathematics pedagogical content knowledge of both categories of future teachers (primary and lower secondary). The assessments were implemented just before these individuals were due to graduate from their preservice teacher education programs.

The survey data elicited came from over 15,000 primary and over 9,000 lower-secondary future teachers and close to 5,000 teacher educators in 500 institutions of preservice teacher education. These institutions included 451 units preparing future primary teachers and 339 units preparing future lower-secondary teachers.

1.4 Sampling Procedure

TEDS-M implemented a two-stage sampling design when drawing the national samples of teacher education institutions/programs, teacher educators, and future teachers. First, the sampling unit of the IEA Data Processing and Research Center (DPC) in Hamburg, Germany, worked with the national research centers in each participating country to select samples representative of the national population of "teacher preparation" institutions offering education to the target population of future teachers (i.e., those preparing to teach mathematics at the primary and/or lower-secondary levels). Once an institution had been selected, all of its programs associated with preparing future teachers of mathematics were included in the survey. Second, each national center used the IEA DPC-provided software package WinW3S to select the samples of future teachers and educators from within these institutions (and programs). These individuals were then asked to complete the surveys and/or knowledge assessments. All samples were drawn using randomization.

The countries participating in TEDS-M were required to provide complete national coverage of their national desired target populations. Some countries found it necessary to select all teacher preparation institutions in order to reach the IEA sampling standards. Nearly every country also found it necessary to survey all eligible educators. Likewise, in the majority of countries, all eligible future teachers in the sampled institutions were surveyed. However, organizational and/or operational conditions made it difficult for some national centers to obtain the complete required coverage. Sampling errors were computed using balanced half-sample repeated replication (or BRR, a well-established resampling method).

1.5 Content of this Report

The rest of this report presents the technical detail associated with TEDS-M. A brief description of the content of each chapter follows.

- *Chapter 2* summarizes the study's framework, instruments for data collection, and guidelines for analyzing and reporting on the data presented in the participating countries' national reports.
- *Chapter 3* sets out the development of the assessment frameworks for the future teachers' mathematics content knowledge and their mathematics pedagogical content knowledge, as well as the content of the assessments and their scoring guides.
- *Chapter 4* describes the conceptual underpinnings and the development of the TEDS-M survey questionnaires. This chapter also includes definitions and descriptions of the TEDS-M target populations (institutions/programs, teacher educators, and future teachers) and of each item included in the questionnaires.
- *Chapter 5* delineates the guidelines and rules for national adaptations to the TEDS-M questionnaires and assessments, as well as for their translation and layout. It also explains the procedures used to verify the national instruments.
- *Chapter 6* details the sampling design.

- *Chapter 7* covers the implementation and administration of the surveys.
- *Chapter 8* focuses on the procedures for quality assurance of the data collection.
- *Chapter 9* describes the process of creating, verifying, and "cleaning" the content of the TEDS-M database.
- *Chapter 10* explains the processes used to estimate sampling weights and participation rates.
- *Chapter 11* describes the study's data-calibration and scale-development processes. It additionally provides an account of the process used to report the assessment and questionnaire data. Also covered is the development of anchor points for the assessments of mathematics knowledge and mathematics pedagogical content knowledge.

The report's appendices detail, amongst other matters, the characteristics of the national samples, set out the guidelines given to the national centers to help them prepare their country reports, and provide various item statistics and scale characteristics.

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Tatto, M. T., Schwille, J., Senk, S. L., Ingvarson, L., Rowley, G., Peck, R., Bankov, M., Rodríguez, M., & Reckase, M. (2012). *Policy, practice, and readiness to teach primary and secondary mathematics in 17 countries: Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-M).* Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

CHAPTER 2:

THE TEDS-M POLICY CONTEXT STUDY

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2.1 Overview

This chapter focuses on the responsibilities, guidelines, instruments, analysis, and reporting associated with the TEDS-M policy context substudy. This study involved an analysis of the national policies relating to mathematics teacher education and of the national contexts in which this area of education takes place. The questions framing this component were these:

- What are the policies that regulate and influence the design and delivery of mathematics teacher education for elementary and lower-secondary teachers?
- What institutions and programs have been established at the national level to implement these policies?
- How do countries' distinctive political, historical, and cultural contexts influence policy and practice in mathematics teacher education?
- What are the policies in each country regarding standards for degrees, coverage of topics, certification practices, recruitment, selection, and preparation of future mathematics teachers?
- How do these policies vary across countries?

2.2 Data Collection

2.2.1 Preliminary Country Questionnaires

The policy study was launched with the implementation of two questionnaires—the TEDS-M sampling frame questionnaire and the TEDS-M route questionnaire. Both were completed at the national level by the TEDS-M national research coordinators (NRCs) or other members of the TEDS-M national teams.

2.2.1.1 TEDS-M sampling frame questionnaire

The *sampling frame questionnaire* (also known as the route questionnaire) asked the NRCs to identify all routes[1] leading to teaching primary school or lower-secondary school mathematics in their system of teacher education. The questionnaire also collected a small amount of information on a few very important characteristics of each of these routes. In particular, the questionnaire asked respondents to provide the grades/standards that the graduates of each route are qualified to teach, the types of school for which they are qualified to teach (e.g., academic, vocational, comprehensive), and the total number of graduates from the route for the latest year in which statistics were available.

1 TEDS-M defined *route* as the sequence of opportunities to learn that lead future teachers from the end of their general secondary schooling to the point at which they are considered fully qualified to teach in primary or lower-secondary schools. A route is thus a prescribed pathway through which teacher education programs are made available in a given country. Teacher preparation programs within a given route share a number of common features that distinguish them from teacher preparation programs in different routes. Different countries have different sets of routes available (see Tatto et al., 2008, pp. 25–26).

The primary purpose of this questionnaire, included in Appendix A of this report, was to produce information needed for the design of each country's probability samples. Once the sampling frame questionnaire had been completed, each country's NRC, the international study centers, the IEA Data Processing and Research Center (DPC), and the sampling referee discussed the routes to be covered by TEDS-M in that country. The information gathered during this process produced not only what was needed for sampling, but also information for the policy study. This information was invaluable in terms of clarifying understanding of how the respective countries organized their teacher education provision.

2.2.1.2 TEDS-M route questionnaire

Once the routes to be studied by TEDS-M had been identified, each NRC completed the *route questionnaire*, designed to provide further information on each route into and through teacher education. Developed by the international teams and revised by NRCs before use, the questionnaire required national centers to draw on diverse sources of information, including interviews and focus groups, as needed. Topics covered were:

- The legislative/regulatory framework for teacher education;
- Characteristics of the institutions, programs, and sequences that make up the route (including duration and numbers of institutions);
- External examinations required and credentials awarded during each phase;
- Nationally prescribed or recommended curriculum content for the routes;
- Nature and amount of school-based practicum experience in the route;
- Levels at which curriculum decisions are made for the route; and
- Qualifications required of teaching staff in the route.

2.2.2 Country Reports from NRCs

How teacher education is organized varies in many ways, both within and across countries. Some of these differences are major in the sense that they are likely to have substantial effects on the amount, scope, and nature of the opportunities to learn offered to future teachers as well as on what they actually learn. In order to understand more fully the nature of these differences, NRCs were asked to produce a country report on national policy pertaining to teacher education in general and its organization and context in particular. These reports were intended to serve two purposes:

1. As a standalone report that, when combined with the reports from all countries, could be published as one of the TEDS-M international reports (subsequently designated the TEDS-M encyclopedia);
2. As input for crossnational analyses of teacher education policy, organization, and context.

Each country report, written by the TEDS-M NRC and/or other members of the TEDS-M national team, constituted a response to guidelines prepared by the TEDS-M international teams. Lawrence Ingvarson and John Schwille took the lead in developing and implementing these guidelines. To make the crossnational report as useful as possible, the information sought aligned with the information obtained through the route questionnaire. The latter produced data that were standardized and therefore directly comparable, whereas the country reports provided the contextual narratives in a qualitative form that enabled interpretation of the crossnational summary statistics.

The country report guidelines provided an overall outline for the content of the national reports as well as an indication of what to include under each heading. The international teams asked that the report include three main parts:

1. Context and organization of teacher education;
2. Quality-assurance arrangements and program requirements; and
3. Funding and reform of teacher education.

Part 1 asked the NRCs to cover the historical, cultural, and social factors that had played a significant role in shaping their country's teacher education system. NRCs were also directed to focus on current policies and issues related to the teacher workforce, the teacher labor market, and teacher quality, and then to document the structure and organization of the teacher education system in their country. The Part 2 guidelines directed NRCs to focus more specifically on quality-assurance policies and program requirements, as applied to, for example, entry into teacher education and full entry to the teaching profession. NRCs were also asked to pay specific attention to teacher education curricula and the requirements of the teaching practicum (field experience). Part 3 of the country report required the NRCs to cover the financing of teacher education as well as any current debates on reforming this area of educational provision.

More specific questions as well as additional guidance were provided under all these headings (reproduced for this volume in Appendix B). In addition, the guidelines called for clarity about the within-country differences across types of teacher education, levels (e.g., elementary, lower secondary), states or provinces in federal systems, and public and private institutions.

A process of consultation with TEDS-M NRCs that involved discussing any matters in the reports requiring clarification or meriting further elaboration followed. The TEDS-M team encouraged NRCs to modify the recommended report outline by tailoring their descriptions and discussion to the distinctive conditions in their respective countries.

Some of the topics covered in the country reports did not elicit the information sought. For example, countries generally were not able to report the costs of teacher education with sufficient accuracy and coverage for this information to be used in reporting TEDS-M findings at the international level. The sections on curricula were generally more limited and general than had been intended. This outcome may simply have meant that discourse at the national level on teacher education and the specific requirements imposed on it are largely framed in ways that apply to all subjects rather than in terms limited and specific to mathematics teacher education. Due to lack of resources, the Russian Federation was unable to provide a country report.

2.3 Analysis and Reporting

The data from the two questionnaires and country reports are described and discussed in three TEDS-M publications: summarily in the main international report (Tatto et al., 2012), from a crossnational perspective in the international report devoted exclusively to the policy context study (Ingvarson et al., 2013), and in the TEDS-M encyclopedia, which contains condensed versions of each country report (Schwille et al., 2013).

2.3.1 International Report on the Policy Study

2.3.1.1 TEDS-M organizational terminology

To avoid ambiguity, some special terminology was developed for TEDS-M. For example, two key terms denote the structure and organization of teacher education: *program* and *program-type*. Program refers to a prescribed course of study leading to a teaching credential. Program-type refers to groups of programs that share similar purposes and structural features, such as the credential earned, the type of institution in which it is offered, whether the program is concurrent or consecutive, the range of school grade levels for which teachers are prepared, and the duration and degree of specialization.

In other words, program-type refers to the distinctive organizational features that differentiate the pathways to becoming qualified to teach. For example, in Poland, one of the teacher education program-types is a relatively new first-cycle Bachelor's degree designed to prepare teachers for integrated teaching in Grades 1 to 3. The opportunities to learn organized for future teachers in this program-type have certain attributes in common regardless of which university is the provider. Also, some of these common features differ from the common features of other program-types in Poland, such as those that prepare mathematics specialists to teach in Grade 4 and above. In contrast, the word program in TEDS-M refers to the particular form or the way a program-type is implemented in a particular institution. In short, the terms program and program-type are meant to replace using the one word, program, which on its own could refer ambiguously both to teacher education as organized in one particular institution and to closely related offerings at multiple institutions.

Thus, whatever National Taiwan Normal University (Chinese Taipei) offers to qualify students in secondary mathematics teacher education is a program, whereas the program-type "secondary mathematics teacher education" consists of the common characteristics of all such programs throughout Chinese Taipei. Multiple programs of the same type in multiple institutions therefore typically make up a program-type. Exhibit 2.1 lists, country by country, all program-types included in the TEDS-M target population together with some of their most important organizational features.

Finally, in order to provide a more comparable and sufficiently large grouping of future teachers across countries, TEDS-M aggregated program-types into *program-groups*.

2.3.2 Organization and Context of Teacher Education

How the countries participating in TEDS-M organize their teacher education varies considerably from one country to another. Ongoing changes in countries' education systems and their teacher education provision contribute to this diversity, making it difficult to give definitive descriptions of teacher education that are likely to apply in the longer term. Nevertheless, the TEDS-M crossnational data indicated that it would be possible to characterize and compare the organization of teacher education in terms of a few key parameters. We discuss each of these below, indicating why they were chosen and what their likely importance is crossnationally. It is important to note that countries differ greatly with respect to which parameters they determine nationally and which they leave to teacher education institutions to decide.

Exhibit 2.1: Organizational characteristics of teacher education program-types in TEDS-M

Country	Program-Type	Consecutive/ Concurrent	Duration (Years)	Grade Span	Specialization	Program-Group	Test Administered
Botswana	Diploma in Primary Education	Concurrent	3	1–7	Generalist	3: Primary–lower secondary (Grade 10 max.)	Primary
	Diploma in Secondary Education, Colleges of Education	Concurrent	3	8–10	Specialist	5: Lower secondary (Grade 10 max.)	Secondary
	Bachelor of Secondary Education (Science), University of Botswana	Concurrent	4	8–12	Specialist	6: Upper secondary (up to Grade 11 and above)	Secondary
Canada							
Ontario	Primary/Junior	Consecutive	4+1	1–6	Generalist	**2:** Primary (Grade 6 max.)	NA
	Junior/Intermediate	Consecutive	4+1	4–10	Generalist and specialist	**Both 3** (primary–lower secondary, Grade 10 max.) **and 5** (lower secondary, Grade 10 max.)	NA
	Intermediate/Senior	Consecutive	4+1	7–12	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	NA
Québec	Primary	Concurrent	4	1–6	Generalist	**2:** Primary (Grade 6 max.)	NA
	Secondary	Concurrent	4	7–11	Specialist	**6:** Upper secondary (up to Grade 11 and above)	NA
Nova Scotia	Primary	Consecutive	4+2	1–6	Generalist	**2:** Primary (Grade 6 max.)	NA
	Secondary (Junior and Senior)	Consecutive	4+2	7–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	NA
Newfoundland-Labrador	Primary/Elementary	Concurrent	5	1–6	Generalist	**2:** Primary (Grade 6 max.)	NA
	Intermediate/Secondary	Consecutive	4+1	7–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	NA
Chile	Generalist	Concurrent	4	1–8	Generalist	**Both 3** (primary–lower secondary, Grade 10 max.) **and 5** (lower secondary, Grade 10 max.)	Both
	Generalist with Further Mathematics Education	Concurrent	4	5–8	Generalist	**5:** Lower secondary (Grade 10 max.)	Secondary
Chinese Taipei	Elementary Teacher Education	Concurrent	4.5	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Secondary Mathematics Teacher Education	Concurrent	4.5	7–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
Georgia	Bachelor of Pedagogy	Concurrent	4	1–4	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Bachelor of Arts in Mathematics	Concurrent	3	5–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Master of Science in Mathematics	Concurrent	5	5–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Master of Science in Mathematics	Consecutive	5	5–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary

Exhibit 2.1: Organizational characteristics of teacher education program-types in TEDS-M (contd.)

Country	Program-Type	Consecutive/ Concurrent	Duration (Years)	Grade Span	Specialization	Program-Group	Test Administered
Germany	Teachers for Grades 1–4 without Mathematics as a Teaching Subject (Type 1B)	Hybrid of the two	3.5+2.0	1–4	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Teachers of Grades 1–9/10 with Mathematics as a Teaching Subject (Type 2A)	Hybrid of the two	3.5+2.0	1–9/10	Specialist (in two subjects)	**Both 4** (primary mathematics specialist) **and 5** (lower secondary, Grade 10 max.)	Both
	Teachers for Grades 1–10 without Mathematics as a Teaching Subject (Type 2B)	Hybrid of the two	3.5+2.0	1–4	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Teachers for Grades 5/7–9/10 with Mathematics as a Teaching Subject (Type 3)	Hybrid of the two	3.5 +2.0	5/7–9/10	Specialist (in two subjects)	**5:** Lower secondary (Grade 10 max.)	Secondary
	Teachers for Grades 5/7–12/13 with Mathematics as a Teaching Subject (Type 4)	Hybrid of the two	4.5+2.0	5/7–12/13	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	Secondary
Malaysia	Bachelor of Education, Primary	Concurrent	4	1–6	Specialist (in two subjects)	**4:** Primary mathematics specialist	Primary
	Diploma of Education (Mathematics)	Concurrent	4+1	1–6	Specialist (in two subjects)	**4:** Primary mathematics specialist	Primary
	Malaysian Diploma of Teaching (Mathematics)	Concurrent	3	1–6	Specialist (in two subjects)	**4:** Primary mathematics specialist	Primary
	Bachelor of Education (Mathematics), Secondary	Concurrent	4	7–13	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Bachelor of Science in Education (Mathematics), Secondary	Concurrent	4	7–13	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	Secondary
Norway	General Teacher Education (ALU) with Mathematics Option	Concurrent	4	1–10	Generalist with extra mathematics	**Both 3** (Primary–lower secondary, Grade 10 max.) **and 5** (lower secondary, Grade 10 max.)	Both
	General Teacher Education (ALU) without Mathematics Option	Concurrent	4	1–10	Generalist	**Both 3** (primary–lower secondary, Grade 10 max.) **and 5** (lower secondary, Grade 10 max.)	Both
	Teacher Education Program (PPU)	Consecutive	3+1 (or 5+1)	8–13	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Master of Science	Concurrent	5	8–13	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	Secondary

Exhibit 2.1: Organizational characteristics of teacher education program-types in TEDS-M (contd.)

Country	Program-Type	Consecutive/ Concurrent	Duration (Years)	Grade Span	Specialization	Program-Group	Test Administered
Oman	Bachelor of Education, University	Concurrent	5	5–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Educational Diploma after Bachelor of Science	Consecutive	5+1	5–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Bachelor of Education, Colleges of Education	Concurrent	4	5–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
Philippines	Bachelor in Elementary Education	Concurrent	4	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Bachelor in Secondary Education	Concurrent	4	7–10	Specialist	**5:** Lower secondary (Grade 10 max.)	Secondary
Poland	Bachelor of Pedagogy Integrated Teaching, First Cycle	Concurrent	3	1–3	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Master of Arts Integrated Teaching, Long Cycle	Concurrent	5	1–3	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Bachelor of Arts in Mathematics, First Cycle	Concurrent	3	4–9	Specialist	**Both 4** (primary mathematics specialist) **and 5** (lower secondary, Grade 10 max.)	Both
	Master of Arts in Mathematics, Long Cycle	Concurrent	5	4–12	Specialist	**Both 4** (primary mathematics specialist) **and 6** (upper secondary, up to Grade 11 and above)	Both
Russian Federation	Primary Teacher Education	Concurrent	5	1–4	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Teacher of Mathematics	Concurrent	5	5–11	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
Singapore	Post-Graduate Diploma in Education, Primary Option C	Consecutive	4+1	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Bachelor of Arts in Education, Primary	Concurrent	4	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Bachelor of Science in Education, Primary	Concurrent	4	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Diploma of Education, Primary Option A	Concurrent	2	1–6	Specialist (in two subjects)	**4:** Primary mathematics specialist	Primary
	Diploma of Education, Primary Option C	Concurrent	2	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Post-Graduate Diploma in Education, Primary Option A	Consecutive	4+1	1–6	Specialist	**4:** Primary mathematics specialist	Primary
	Post-Graduate Diploma in Education, Lower Secondary	Consecutive	4+1	7–8	Specialist (in two subjects)	**5:** Lower secondary (Grade 10 max.)	Secondary
	Post-Graduate Diploma in Education, Secondary	Consecutive	4+1	7–12	Specialist (in two subjects)	**6:** Upper secondary (up to Grade 11 and above)	Secondary

Exhibit 2.1: Organizational characteristics of teacher education program-types in TEDS-M (contd.)

Country	Program-Type	Consecutive/ Concurrent	Duration (Years)	Grade Span	Specialization	Program-Group	Test Administered
Spain	Teacher of Primary Education	Concurrent	3	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
Switzerland	Teachers for Grades 1–2/3	Concurrent	3	1–2/3	Generalist	**1:** Lower primary (Grade 4 max.)	Primary
	Teachers for Primary School (Grades 1–6)	Concurrent	3	1–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Teachers for Primary School (Grades 3–6)	Concurrent	3	3–6	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Teachers for Secondary School (Grades 7–9)	Concurrent	4.5	7–9	Generalist, some specialization	**5:** Lower secondary (Grade 10 max.)	Secondary
Thailand	Bachelor of Education	Concurrent	5	1–12	Specialist	**Both 4** (primary mathematics specialist) **and 6** (upper secondary, up to Grade 11 and above)	Both
	Graduate Diploma in Teaching Profession	Consecutive	4+1	1–12	Specialist	**Both 4** (primary mathematics specialist) **and 6** (upper secondary, up to Grade 11 and above)	Both
United States	Primary Concurrent	Concurrent	4	1–3/4/5	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Primary Consecutive	Consecutive	4+1	1–3/4/5	Generalist	**2:** Primary (Grade 6 max.)	Primary
	Primary + Secondary Concurrent	Concurrent	4	4/5–8/9	Specialist	**Both 4** (primary mathematics specialist) and 5 (lower secondary, Grade 10 max.)	Both
	Primary + Secondary Consecutive	Consecutive	4+1	4/5–8/9	Specialist	**Both 4** (primary mathematics specialist) **and 5** (lower secondary, Grade 10 max.)	Both
	Secondary Concurrent	Concurrent	4	6/7–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary
	Secondary Consecutive	Consecutive	4+1	6/7–12	Specialist	**6:** Upper secondary (up to Grade 11 and above)	Secondary

Source: Tatto et al. (2012), pp. 29–32.

2.3.2.1 Key organizational parameters

2.3.2.1.1 Concurrent and consecutive program-types

The distinction between concurrent and consecutive program-types is one of the ways to distinguish the organization of teacher education in TEDS-M, both within and across countries. Concurrent program-types grant future teachers a single credential for studies in subject-matter content, pedagogy, and other courses in education. All of this learning happens simultaneously (concurrently) during the first period of postsecondary education. In contrast, consecutive teacher education program-types require completion of two phases of postsecondary education: first, a university degree with specialization in the subject-matter to be taught, followed by a separate second phase of study focused primarily on pedagogy and practicum.

The only TEDS-M country for which this distinction did not closely apply was Germany, where preparation for teaching is spread across two phases. The first takes place in universities. The second—practical—phase occurs in special institutions within each federal state and under the jurisdiction of that state. In addition to coursework in academic subjects, the first phase includes classes in subject-specific pedagogy and general pedagogy. During the second phase, future teachers pursue further study while taking full responsibility for teaching assigned classes in primary or secondary schools.

Although the distinction between concurrent and consecutive program-types is widely used, few systematic crossnational studies have investigated how the two differ in regard to curricula and practices, except for the fact that consecutive tend to place all or most of their subject-matter content early in the program and their pedagogical content and field experience toward its end. The TEDS-M findings have narrowed that gap in understanding.

A third type of program, namely, the school-based program, is now widely available in some countries, such as the United States, and runs in addition to the consecutive and concurrent program-types. The school-based type of program takes more of an apprenticeship approach to learning to teach. It is not, however, represented in the TEDS-M database.

2.3.2.1.2 School grade levels for which a program-type prepares teachers

One of the most obvious ways in which to classify teacher education program-types is in terms of whether they prepare teachers for primary or secondary schools. However, it quickly became apparent in TEDS-M that this distinction would be an over-simplification. The terms primary and secondary do not mean the same thing from country to country.

For example, a number of countries, such as Chinese Taipei, Georgia, and Malaysia, have primary programs that prepare teachers to teach from Grades 1 to 6 because these grades constitute primary school in those countries. Other countries, such as Botswana, Chile, and Thailand, have program-types that also start at kindergarten or Grade 1 and extend up to Grade 7, Grade 8, and even Grade 12, respectively. At the other extreme, primary school in most German states is limited to Grades 1 to 4. Chile and Norway have only one type of program for preparing teachers for primary and lower-secondary schools and so make little or no distinction between the preparation of teachers for the early grades and for the middle grades. Their approach is radically different from the approach in countries such as Chinese Taipei and Germany where there is considerable differentiation.

Grade spread is another useful indicator of policy decisions (albeit shaped by tradition and history) about the extent to which the teacher workforce should be unified in its knowledge base and practice. As Exhibit 2.1 shows, these differences in grade span were reflected in the decisions that the TEDS-M researchers made about which instruments to administer for each program-type.

2.3.2.1.3 Program-type duration

The TEDS-M programs preparing primary teachers are usually four years long, but there is some variation. Exhibit 2.1 shows the duration of the countries' single-phase concurrent program-types. It also shows the duration of the first phase and second phase of countries' consecutive program-types (e.g., four years for Phase 1 and one year for Phase 2). Programs preparing secondary teachers also show some variation. Concurrent program-types commonly require four years of study. The first phase of consecutive program-types typically lasts four years and the second phase one year. Germany, where the first phase usually lasts three and a half or four and a half years and the second phase lasts two years, is again the exception.

As is the case with grade span, program duration is a key aspect of higher education policy. According to the literature, variation in the duration of teacher education within and across countries is striking, ranging in the sources consulted from a few months to eight years (Dembélé, 2005; Lewin & Stuart, 2003; OECD, 2005, Stuart & Tatto, 2000; Tatto, 1997a, 1997b, 2008; Tatto, Lehman, & Novotná, 2010). This variation is due to various conditions, including economic constraints, the relationship between the demand for and the supply of teachers, the education level of available applicants to teacher education, and (in particular) the amount and quality of those applicants' subject-based and pedagogical-based content knowledge.

2.3.2.1.4 Subject-matter specialization

Program-types can also be classified according to whether they prepare generalist teachers or specialist teachers of mathematics. In TEDS-M, the primary school teachers in most of the participating countries were being prepared as generalists destined to teach most if not all of the core subjects in the school curriculum. However, some of the countries were also preparing specialist teachers of mathematics to teach below Grade 6.

Specialization tended to be the norm in lower-secondary schools across the TEDS-M countries, although in most cases this meant teaching not one but two main subjects, such as mathematics and science. Without keeping the degree of specialization in mind, it would be misleading to compare programs that differ in this respect. A future teacher being prepared to specialize in teaching mathematics is likely to learn more mathematics content knowledge than a future teacher being prepared to teach more than one subject.

However, the differences between being prepared to teach one, two, three, or more teaching subjects are not necessarily clear-cut. In some of the country reports, authors spoke of future teachers studying aspects of a second or third subject but were not explicit about whether and under what conditions these students would be able to teach those subjects. TEDS-M addressed this problem by classifying each program-type in terms of primarily teaching only one subject, primarily teaching only two subjects (mathematics and one other), and primarily teaching three or more subjects (i.e., the generalist).

Also, in some countries, practicing teachers teach “out of field,” that is, in a subject for which they are neither adequately prepared nor qualified according to the countries’ official expectations of teachers of those subjects. In this and other respects, the state of preparation among the future teachers surveyed by TEDS-M may be very different from the situation among practicing teachers. Exhibit 2.1 above shows the degree of specialization in each of the program-types included in TEDS-M.

2.3.2.1.5 Relative size of different program-types

Paying attention to the relative size of program-types is essential to understanding the structure of teacher education in any one country. Nonconsideration of this matter could easily lead to the assumption that some programs are bigger than they are in reality, and also that they are less marginal than they actually are in meeting the demand for new teachers.

The country by country graphs in the summary chapter (Chapter 2) of the TEDS-M policy report illustrate the extent to which the number of future teachers in the TEDS-M target population varied across program-types. For each country, the graph indicated which program-types were producing the most graduates and which the fewest (for an example, see the right-hand graph in Exhibit 2.2 on the next page). This estimate of program-type enrollments in the last year of teacher education was based on the sum of weights from the achieved TEDS-M sample.

These sums of weight were unbiased estimates of the actual total number of future teachers in the target population broken down by program-type. The estimates were necessary because countries rarely collect and maintain this type of data, even at national levels, and especially in the case of teacher education for lower-secondary schools where interest for TEDS-M lay not in the total number of future teachers preparing to become lower-secondary teachers, but in those future teachers preparing to teach mathematics as their only or as one of their two main teaching subjects. National educational statistics are also not ordinarily maintained on numbers of secondary future teachers by subject-matter specialization.

2.3.2.2 Usefulness of key parameters in terms of characterizing teacher education at the national level

Examination of the key parameters described in this chapter indicated that classifying program-types into concurrent versus consecutive and elementary versus secondary greatly oversimplified the organizational characteristics of teacher education at national levels. Our more precise crossnational analysis of organizational features suggested that some of these characteristics, including those examined in depth in other TEDS-M reports, do have a major impact on the opportunities to learn and outcomes associated with teacher education. One hypothesis developed during the policy study was that three of the variables (highest grade level for which future teachers are prepared, the duration of the program-type, and the greatest degree of subject-matter specialization) are those especially powerful in shaping opportunities to learn and outcomes.

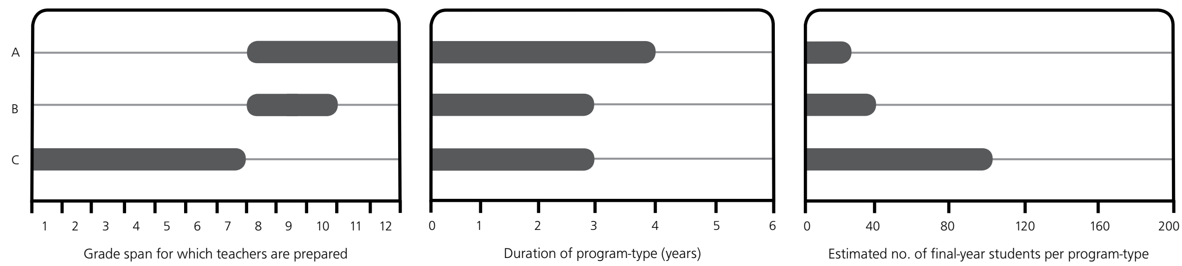
2.3.3 The Distinctive National Imprint of Each TEDS-M System

Although national systems of teacher education have many commonalities, at least in terms of key organizational parameters, each also has its own particular characteristics. This national imprint is rooted in history and reflects a particular cultural, social, and political context. Therefore, for the policy study, we also compiled from standard statistical sources on the internet a comparison of the 17 countries in terms of relevant demographic and development indicators (see Ingvarson et al., 2013). Furthermore, on the basis of the country reports and subsequent crossnational analyses, we wrote a brief capsule summary of the salient, distinctive organizational features of the teacher education systems represented in TEDS-M. Although the countries and their teacher education systems paralleled one another in various respects, each country also differed from the other countries in distinctive, nonparallel ways that need to be taken into account when analyzing and interpreting TEDS-M survey and assessment data.

Because each program-type reported on in TEDS-M had developed its own distinctive character in response to different policies and contexts, the capsule summaries were necessary to portray the distinctive characteristics and context of each national system in terms of what the national report authors deemed was most important for readers to know when considering the TEDS-M data. In addition to a narrative explanation, each summary contains three graphs, designed to give an immediate visual image of the diversity of program-types within and between countries.

The graphs are based on Exhibit 2.1 in this chapter and on the aforementioned table of sums of weights by program-type. Exhibit 2.2, featuring Botswana, is an example of this graphic. The three organizational characteristics portrayed in each set of graphs are the same as those discussed above—the grade span for which systems prepare teachers, the duration of each program-type (i.e., the total number of years of postsecondary education required to become fully qualified), and the size of the program-type in terms of number of future teachers in their final year of preparation (as estimated from the TEDS-M sample).

Exhibit 2.2: Example graphic: Teacher education program-types in Botswana



Key to program-type

A—Bachelor of Secondary Education (Science), university

B—Diploma of Secondary Education, colleges of education

C—Diploma in Primary Education

Note: Because the Postgraduate Diploma in Education one-year consecutive program produces very few graduates, it was not included in the TEDS-M target population. The Bachelor of Primary Education at the university was also excluded because of a lack of students. The Bachelor of Education (secondary) program was not included because it is intended for practicing teachers who have at least two years of teaching experience. It was therefore outside the scope of TEDS-M.

Source: Ingvarson et al. (2013), p. 42.

The narrative accompanying this graphic summarizes the distinctive national context information required for understanding these program-types and for interpreting the survey and assessment data presented in other TEDS-M reports. These characteristics are discussed under three headings:

1. Institutions and governance;
2. Program-types and credentials; and
3. Curriculum content, assessment, and organization.

2.3.4 Crossnational Comparison of Quality-Assurance Policies

International interest in policies that promote teacher quality has increased markedly in recent years. With mounting evidence that the major in-school influence on student achievement is teachers' knowledge and skill, policymakers have been giving closer attention to strategies likely to recruit, prepare, and retain the best possible teachers. Each country deals with these issues in its own way. Some countries have specific policies to ensure that teaching presents an attractive career option in comparison with other professions. Some have national agencies with responsibility for selecting entrants to teacher education programs. Others leave the selection to individual universities and other teacher education providers.

Part 2 of the international report on the policy study documents the quality-assurance arrangements operating in the countries that participated in TEDS-M. It addresses the following questions:

- *Recruitment and selection:* Who decides, and how, which students gain entry to teacher education programs? What policies and agencies are in place to monitor and assure the quality of entrants to teacher education? What are the standards or requirements for eligibility to enter programs for preparing teachers of mathematics? How do the academic standards of entrants to teacher education compare with standards for entry to most other university or professional preparation programs?
- *Accreditation of teacher education institutions:* Who decides, and how, which institutions are allowed to train teachers? What policies and agencies are in place to monitor and assure the quality of teacher education institutions and programs? What procedures are used to assess and accredit the quality of teacher education institutions or programs? What requirements are laid down for the curriculum, field experience (practicum in schools), and staffing in teacher education institutions and programs?
- *Entry to the teaching profession:* Who decides, and how, which students meet the requirements for full entry to the profession? What policies and agencies are in place to monitor and assure that graduates are competent and qualified to gain certification and full entry to the profession?

The last part of the international policy report brings together the findings generated by these questions and summarizes arrangements for assuring the quality of teacher education programs. The TEDS-M international research teams rated each type of policy in terms of its strength (i.e., a weak through to a strong policy) and then combined these ratings in an overall rating. This second group of ratings provided the basis for a preliminary investigation into the relationship between quality-assurance arrangements and the quality of graduates from teacher education programs. At this level, the relationship was found to be strongly positive.

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CHAPTER 3:

DEVELOPMENT OF THE TEDS-M MATHEMATICS ASSESSMENT FRAMEWORKS, INSTRUMENTS, AND SCORING GUIDES

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3.1 Overview

The knowledge teachers use when teaching mathematics was a key TEDS-M outcome variable. It consisted of two hypothesized dimensions—mathematics content knowledge (MCK) and mathematics pedagogical content knowledge (MPCK). The first step that the TEDS-M research team took when developing the TEDS-M mathematics assessment instruments was to conceptualize the TEDS-M frameworks for these two dimensions.

The MCK and MPCK frameworks developed for the study that preceded TEDS-M, known as Mathematics Teaching for the 21st Century or MT21 (Schmidt, Blömeke, & Tatto, 2011), informed the TEDS-M conceptualizations. However, because MT21 focused on the lower-secondary level only, a considerable amount of work was needed to extend these conceptualizations to include future primary teachers. The same was true of the assessment frameworks eventually developed for the two dimensions of knowledge. That work included drawing on other studies of mathematics education. The specifications eventually established for the TEDS-M assessment frameworks required, in turn, the development of a large number of items designed to measure the MCK and MPCK of the future teachers who participated in the study.

The elaboration of the TEDS-M mathematics assessment frameworks, items, and instruments was a collaborative process lasting almost four years, from the fall of 2003 to the fall of 2007. To ensure that TEDS-M reflected an international perspective, the people involved in developing both the assessment framework and the test included prominent mathematicians, mathematics educators, and psychometricians. Together, they represented a range of nations and cultures.

In this chapter, we describe and discuss the conceptualization and development of the TEDS-M frameworks for MCK and MPCK. We also explain how the international pool of items was developed, refined, selected, and categorized. In the final part of the chapter, we look at the design of the instruments and assessment booklets as well as the development of the scoring guides.

3.2 Developing the TEDS-M 2008 Assessment Frameworks

Building on the work of past studies in mathematics education, the TEDS-M research team developed an assessment framework for each of the two dimensions of mathematics knowledge for teaching.

In order to maximize connections with other international studies, the Grades 4 and 8 mathematics frameworks for the 2007 iteration of the Trends in International Mathematics and Science Study (TIMSS) (Mullis et al., 2005) and the 2008 TIMSS Advanced frameworks (Garden et al., 2006) were used as the basis of the frameworks designed to assess the MCK of students enrolled in teacher preparation programs.

The framework for MPCK required more extensive development. While educational stakeholders accept MPCK as a meaningful and important construct (see, for instance, Hill, Sleep, Lewis, & Ball, 2007), there is no corresponding consensus worldwide on how best to categorize and describe the aspects of this dimension of mathematics knowledge for teaching (Even & Ball, 2009). Differences exist, for example, between the European notion of didactics (Pepin, 1999) and the Anglo/American notion of pedagogical content knowledge (Shulman, 1986). The involvement of countries with an Asian culture of pedagogy in TEDS-M further enriched and added to the complexity of the development of an MPCK framework that would fairly represent the countries involved. The careful description and measurement of MPCK during TEDS-M was a product of the contribution that each country participating in TEDS-M made to these processes.

3.2.1 The Mathematics Content Knowledge (MCK) Framework

The MCK of interest in TEDS-M was that required to teach primary and lower-secondary school students. All MCK items developed by TEDS-M were categorized according to three domains: content, cognitive, and curricular level (Tatto et al., 2008). After the team of TEDS-M researchers who developed the items for the MCK assessment had finished categorizing each item to one of these domains, panels of experts in mathematics education along with members of the national research teams reviewed the categorizations. This process led to all items in each domain of the MCK instruments being classified according to subdomains:

1. Content domain (subdomains of number and operations, geometry and measurement, algebra and functions, data and chance);
2. Cognitive domain (subdomains of knowing, applying, reasoning); and
3. Curricular-level domain (subdomains of novice, intermediate, advanced).

3.2.1.1 Content subdomains

Although the mathematics knowledge that teachers of lower-secondary students need is not the same as that which teachers of primary school students need, TEDS-M used the same broad subdomains of number and operations, geometry and measurement, algebra and functions, and data and chance for both. Exhibit 3.1 shows the content knowledge framework that TEDS-M adapted from TIMSS 2007 (Mullis et al., 2005) and TIMSS Advanced 2008 (Garden et al., 2006). As is evident from the exhibit, TEDS-M researchers considered most of the mathematics content listed in Exhibit 3.1 to be appropriate for both future primary and secondary teachers. However, content related to advanced topics in algebra and functions was deemed suitable for the lower-secondary students only.

Exhibit 3.1: Mathematics content knowledge framework: content knowledge subdomains and content areas

Subdomain	Content Areas
Number and Operations	Whole numbers (*ps*) Fractions and decimals (*ps*) Number sentences (*ps*) Patterns and relationships (*ps*) Integers (*ps*) Ratios, proportions, and percentages (*ps*) Irrational numbers (*ps*) Number theory (*ps*)
Geometry and Measurement	Geometric shapes (*ps*) Geometric measurement (*ps*) Location and movement (*ps*)
Algebra and Functions	Patterns (*ps*) Algebraic expressions (*ps*) Equations/formulas and functions (*ps*) Advanced topics, e.g., limits, continuity, matrices (*s*)
Data and Chance	Data organization and representation (*ps*) Data reading and interpretation (*ps*) Chance (*ps*)

Note: *p* = primary level; *s* = lower-secondary level.

The TEDS-M researchers initially planned to give approximately equal emphasis to all four content subdomains. However, subsequent analyses of the primary and secondary mathematics curricula and the teacher preparation curricula in the participating countries indicated that some countries gave lesser emphasis to data and chance than to the other three content subdomains. Consequently, number and operations, algebra and functions, and geometry and measurement received more emphasis than data and chance in the MCK assessment instruments used in TEDS-M.

3.2.1.2 Cognitive subdomains

TEDS-M adopted the three cognitive subdomains—knowing, applying, and reasoning—used in TIMSS 2007 and TIMSS Advanced 2008. These subdomains were described by Garden et al. (2006, p. 17) as follows:

> Understanding a mathematics topic consists of having the ability to operate successfully in three cognitive subdomains. The first domain, knowing, covers the facts, procedures, and concepts students need to know, while the second, applying, focuses on the ability of students to make use of this knowledge to select or create models and solve problems. The third domain, reasoning, goes beyond the solution of routine problems to encompass the ability to use analytical skills, generalize, and apply mathematics to unfamiliar or complex contexts.

Exhibit 3.2 sets out the behaviors associated with each of these three cognitive subdomains. As was the case for TIMSS 2007 and TIMSS Advanced 2008, TEDS-M aimed to achieve a balance of MCK items across the cognitive subdomains in terms of approximately 35 percent knowing, 35 percent applying, and 30 percent reasoning.

Exhibit 3.2: Mathematics content knowledge framework: cognitive subdomains and behaviors associated with them

Subdomain	Associated Behaviors
Knowing	Recall, recognize, compute, retrieve, measure, classify/order
Applying	Select, represent, model, implement, solve routine problems
Reasoning	Analyze, generalize, synthesize/integrate, justify, solve nonroutine problems

Source: Mullis et al. (2005, pp. 33–38).

3.2.1.3 Curricular levels

In order to gain a deeper understanding of the knowledge needed to teach mathematics, TEDS-M sought information as to which level of school mathematics curricula each participating future teacher would be able to teach. All MCK items were therefore categorized into one of three curricular levels—novice, intermediate, and advanced. Exhibit 3.3 provides the descriptions of each adopted for TEDS-M.

TEDS-M researchers agreed that, given the limited assessment time available for future teachers to answer each TEDS-M assessment (60 minutes), the focus of the mathematics knowledge items should be on the novice and intermediate levels. For example, future teachers of primary school students would be tested mostly on the mathematics taught up to Grade 8, while future teachers of lower-secondary school students would be tested mostly on mathematics up to Grade 10. However, in order to gain information about future teachers with more advanced MCK, the TEDS-M team also developed some advanced-level items.

Exhibit 3.3: Mathematics content knowledge framework: curricular levels

Curricular Level	Description
Novice	Mathematics content that is typically taught at the grades the future teacher is preparing to teach.
Intermediate	Mathematics content that is typically taught one or two grades beyond the highest grade the future teacher is preparing to teach.
Advanced	Mathematics content that is typically taught three or more years beyond the highest grade the future teacher is preparing to teach.

3.2.2 The Mathematics Pedagogical Content Knowledge (MPCK) Framework

Three studies that particularly informed the development of the TEDS-M MPCK framework were the international MT21 study (Schmidt et al., 2011), the German-based COACTIV study (Kunter et al., 2007), and the work of the Learning Mathematics for Teaching (LMT) project in the USA (see, for example, Ball & Bass, 2000; Hill & Ball, 2004; Hill, Rowan, & Ball, 2005; Hill, Schilling, & Ball, 2004). The TEDS-M expert panels (consisting of internationally prominent mathematicians and mathematics educators) and the TEDS-M national research coordinators (NRCs) provided feedback on initial drafts of the MPCK framework. As was the case with development of the MCK assessment framework, the TEDS-M researchers needed to categorize the items in the MPCK assessment framework to ensure a balanced assessment of MPCK. The items were therefore classified according to:

1. Content domain (subdomains of number and operations, geometry and measurement, algebra and functions, and data and chance);
2. MPCK-specific domain (subdomains of curricular knowledge, planning for mathematics teaching and learning, enacting mathematics for teaching and learning); and
3. Curricular level (subdomains of novice, intermediate, and advanced levels).

The descriptions immediately below as well as the information contained in Exhibit 3.4 elaborate the final MPCK-specific framework used for both the primary and the lower-secondary item development.

The curricular subdomain refers to mathematical curricular knowledge and comprises the preliminary theoretical knowledge that a teacher should possess in order to teach effectively. It covers, among other elements, knowledge about the curriculum and student learning trajectories, knowledge about teaching goals and formative and summative assessment, and knowledge of key concepts in school mathematics and their interconnections.

This planning subdomain refers to the knowledge teachers need to plan their mathematics teaching and learning and refers to the preparatory work that they need to do before teaching in the classroom. The items for this subdomain on the assessment were therefore directed at, for example, assessing lesson-planning activities, selecting appropriate instruction methods and designs, using classroom assessment to inform and plan lessons, and predicting students' reactions and possible misconceptions.

The third subdomain, enacting, refers to the enactment of mathematics for teaching and learning and includes the main activities that may happen in the classroom during a lesson. Teachers viewed from this subdomain are seen not only as lecturers but also as people who play an interactive role in the classroom. The TEDS-M assessment goal in this area was to measure, among other competencies, ability to analyze teacher and student interaction following students' questions, develop solutions, consider and respond to argumentation and misconceptions, provide explanations, and give feedback.

Exhibit 3.4: Mathematics pedagogical content knowledge (MPCK) framework [a]

MPCK Subdomain	Elaboration
Mathematical Curricular Knowledge	• Establishing appropriate learning goals • Knowing different assessment formats • Selecting possible pathways and seeing connections within the curriculum • Identifying the key ideas in learning programs • Knowing the mathematics curriculum
Knowledge of Planning for Mathematics Teaching and Learning (Preactive)	• Planning or selecting appropriate activities • Choosing assessment formats • Predicting typical student responses, including misconceptions [b] • Planning appropriate methods for representing mathematical ideas • Linking the didactical methods and the instructional designs • Identifying different approaches for solving mathematical problems • Planning mathematical lessons
Enacting Mathematics	• Analyzing or evaluating students' mathematical solutions or arguments • Analyzing the content of students' questions • Diagnosing typical student responses, including misconceptions • Explaining or representing mathematical concepts or procedures • Generating fruitful questions • Responding to unexpected mathematical issues • Providing appropriate feedback

Notes:

a This framework paid attention to the temporal dimension of teacher knowledge as well as the way in which mathematical categories refer to different types of knowledge.

b Attention to choice of verbs may prove useful in distinguishing between the preactive and interactive dimensions of the categories.

3.2.3 Developing the Mathematics and Mathematics Pedagogy Items

Developing the item pool for TEDS-M was an international collaborative process. Permission was granted to include some items from past studies of mathematics teachers' knowledge, namely the aforementioned MT21 study and the Learning Mathematics for Teaching (LMT) project at the University of Michigan (see http://sitemaker.umich.edu/lmt/home), as well as the Knowing Mathematics for Teaching Algebra (KAT) project at Michigan State University (see http://www.educ.msu.edu/kat/). The TEDS-M researchers from the international study centers (ISCs) in Australia (ACER) and the United States (MSU), the NRCs in the participating countries, and the expert panels of mathematics researchers and educators from around the world contributed additional items.

Draft items were submitted to the ISCs for review, a process designed to ensure the TEDS-M instruments aligned with the assessment frameworks. MSU had primary responsibility for the pool of items for the future teachers preparing to teach primary school, and ACER for the items for the lower-secondary future teachers. This process resulted in an initial item pool of about 500 items across both levels, covering a broad range of MCK and MPCK topics.

In the remainder of this section, we give a brief overview of the challenges associated with the item development work, as well as a more detailed account of the steps taken to develop the two pools of items used in the TEDS-M main study. These steps included item review and revision, pilot testing of the items and their answer formats, and final selection of the items for the main survey.

3.2.4 Methodological and Measurement Considerations

These considerations were informed by one of the TEDS-M research questions: How can the outcomes of teacher education programs for teachers of mathematics be measured in ways that are reliable and valid? A range of robust items (mathematically clear, culturally valued, and psychometrically sound) was needed in order to develop reliable and valid measures of future teachers' MCK and MPCK.

The TEDS-M researchers faced several challenges when developing the items that could be used to measure MPCK. We have already discussed one such challenge—identifying and delineating the two hypothesized dimensions forming mathematical knowledge for teaching. Creating items that would motivate future teachers to participate in the TEDS-M research was a second challenge. Determining which of the two dimensions of teachers' mathematics knowledge each item contributed to was a third.

To meet the second challenge, the TEDS-M researchers focused their item-development work on items set in teaching and learning contexts, an approach similar to that taken in the recent studies of mathematics teachers' knowledge cited earlier in this chapter (i.e., MT21, COACTIV, and LMT). Development of the MPCK items also referenced mathematics problems appropriate to the level at which the future teachers were being prepared to teach. The assumption here was that items developed according to these considerations would be interesting for the future teachers because of the items' close connection with these preservice teachers' eventual profession.

The third challenge—whether each item contributed most to MCK or MPCK—arose when the TEDS-M researchers decided that the items used in the main TEDS-M survey should contribute to one of the dimensions only. This approach contrasted with that used in the MT21 study and the TEDS-M field trial, where some assessment items measured both dimensions. The TEDS-M international centers therefore asked the members of the expert panels as well as the TEDS-M NRCs to classify items as either MCK or MPCK and then to discuss those items that could not be readily classified or where there was disagreement over the classification.

3.2.5 Initial Item Review and Revision

The TEDS-M ISCs assembled, reviewed, and revised the draft items and confirmed the classification of items with respect to the frameworks and submitted them for review by an expert panel consisting of mathematicians and mathematics educators from the countries that intended to participate in TEDS-M. Selected draft items were pilot-tested in four countries.

Finally, working from the frameworks described earlier, two expert panels (one for the future primary teachers and the other for the future lower-secondary teachers) classified and rated the items and refined the most promising ones. They also, where necessary, added in items for those domain and subdomain areas lacking coverage.

3.2.6 The Field Trial

To evaluate the international performance of the items developed for TEDS-M, a full-scale field trial was conducted at both the primary and lower-secondary levels. In total, 11 countries submitted data from the field trial. To ensure that an adequate number of items would be available for selection, substantially more items, particularly constructed-response ones, were field-tested than were needed in the main study (140% to 180% more). In total, 179 primary-level items in seven assessment booklets and 199 lower-secondary-level items in five assessment booklets were field-tested.

The IEA Data Processing and Research Center produced data almanacs containing basic item statistics for each country and internationally. The almanacs reported item difficulty, how well items discriminated between high-performing and low-performing students, the frequency of distracters in the multiple-choice items, scoring reliability for constructed-response items, and the frequency of occurrence of diagnostic codes used in the scoring guides.

3.2.7 Item Selection for the Main Study

The TEDS-M ISCs conducted an initial review of the field trial results, which identified translation-related problems that could affect the reliability and validity of the items used in the main international study. The expert panels also reviewed the field-trial items and item statistics for any anomalies. Items that had not worked well psychometrically, such as those which had point-biserial correlations lower than 0.2 or poor fit identified through item response theory (IRT) modeling, were deleted. Revisions to items included improving graphics and item layout, clarifying stems, and revising or deleting distracters selected by very low percentages of respondents. In a few instances, item format was changed. These prepared items were then submitted to the NRCs for their review. They recommended a number of additional improvements, most of which were incorporated into the final instruments.

3.2.8 Item Compilations and Booklet Design for the Main Study

Experience gained from MT21 and the TEDS-M item pilot and field trials indicated the feasibility of reliably assessing three subdomains for MCK (number, algebra, and geometry) and at least one subdomain for MPCK in the 60 minutes of testing time available (see below). TEDS-M classifications for the MCK cognitive subdomains and curricular levels were used solely during test development in order to achieve a good balance among these categories of the framework, and not for reporting.

In order to ensure the required coverage of all domains and subdomains in the frameworks, the total pool of items for TEDS-M required much more testing time than could be allotted to any one individual future teacher. Therefore, as occurs in other IEA studies, TEDS-M employed a rotated block design. This involved dividing the entire item pool into unique blocks of items, distributing these blocks across a set of booklets, and rotating the booklets among the future teachers at both primary and secondary levels.

Five blocks of items (B1PM to B5PM) were used for the TEDS-M main survey at the primary level (see Exhibit 3.5). Due to time constraints and the number of items required per subdomain, it was not possible to achieve a balanced incomplete block (BIB) design where every pair of blocks appeared together once in a booklet. A primary-level BIB design reporting on five subdomains would have required an individual primary future teacher to attempt 75 items in 60 minutes. This was considered too many, especially given the nature and proportion of the MPCK items and the likelihood of returning an unacceptably high proportion of missing responses. The design that the TEDS-M researchers eventually selected required about 50 items to be attempted in 60 minutes. As can be seen from Exhibit 3.5, the block rotation still ensured that every block appeared in each position of a test booklet once.

Exhibit 3.5: Design for primary blocks

Booklet	Primary Mathematics Blocks
Booklet 1	B1PM, B2PM
Booklet 2	B2PM, B3PM
Booklet 3	B3PM, B4PM
Booklet 4	B4PM, B5PM
Booklet 5	B5PM, B1PM

Note: B1PM to B5PM = mathematics blocks primary (1–5).

At the lower-secondary level, the small size of the target populations within institutions, within programs, and within countries imposed still further restrictions. The TEDS-M research teams therefore considered three blocks of items (B1SM to B3SM) to be appropriate for the main study's lower-secondary assessment. Exhibit 3.6 shows the three-booklet, three-block BIB design used for this target population. It required the future teachers to answer about 40 items in the 60 minutes available. It also permitted estimation and analysis of the full covariance matrix. The rotated-block design for both the primary and lower-secondary assessments included enough items and score points to generate IRT scales and reports for the subdomains listed above.

Exhibit 3.6: Design for lower-secondary blocks

Booklet	Secondary Mathematics Blocks
Booklet 1	B1SM, B2SM
Booklet 2	B2SM, B3SM
Booklet 3	B3SM, B1SM

Note: B1SM to B3SM = mathematics blocks lower secondary (1–3).

3.2.9 Assembling the Item Blocks for Inclusion in the Booklets

The item blocks were assembled to create a balance across booklets with respect to the content and cognitive domains, curricular level, and item format. The TEDS-M researchers decided that future teachers' performance on items related to the subdomains of algebra, geometry, and number would be reported on. However, while they agreed that the MCK assessment should include data items at both the primary and lower-secondary levels so as to more completely represent the overall MCK dimension, they decided that performance on this subdomain would not be reported on for the reason given in Section 3.2.1.1 above.

The researchers similarly decided that items relating to the curriculum and planning subdomains for the MPCK dimension at both primary and lower-secondary levels should be combined so that future teachers' performance on only two subdomains (curriculum and planning, and enacting) would be reported (see Brese & Tatto, 2012; Tatto et al., 2012). The number of items per block for the primary level is shown in Exhibit 3.7; the numbers for the lower-secondary level can be found in Exhibit 3.8.

Exhibit 3.9 shows the number of MCK items in the content, cognitive, and curricular domains in the final instruments. Both the primary and lower-secondary instruments had an approximately equal balance of items assessing knowledge of number, geometry, and algebra, but only a small number of data items. This outcome led to the previously mentioned decision not to report the data subdomain. Forty-seven percent of the items in the final primary instruments were classified as knowing, 33 percent as applying, and 17 percent as reasoning. The lower than intended proportion of reasoning items was a function of the relatively small number of reasoning items that survived selection into the final item pool for the primary level.

Exhibit 3.7: Primary items by subdomains and blocks

	Number of Items in Block					Items
Subdomain	B1PM	B2PM	B3PM	B4PM	B5PM	Total
Algebra	2	6	6	9	2	25
Geometry	4	2	8	4	8	26
Number	8	7	4	5	8	32
Data [a]	1	1	4	0	1	7
Mathematics Pedagogy 1 (Curriculum and Planning)	5	2	3	3	4	17
Mathematics Pedagogy 2 (Enacting)	2	3	4	7	1	17
Total	22	21	29	28	24	124

Note: a Data was not a reporting subdomain.

Exhibit 3.8: Lower-secondary items by subdomains and blocks

	Number of Items in Block			Item
Subdomain	B1SM	B2SM	B3SM	Total
Algebra	11	8	3	22
Geometry	9	9	11	29
Number	10	7	15	32
Data [a]	1	1	2	4
Mathematics Pedagogy 1 (Curriculum and Planning)	8	4	1	13
Mathematics Pedagogy 2 (Enacting)	1	9	6	16
Total	40	38	38	116

Note: a Data was not a reporting subdomain.

Exhibit 3.9: Distribution of the MCK items across the mathematics content subdomains

Content Subdomain	Number of Items		Cognitive Subdomain	Number of Items		Curricular Level	Number of Items	
	Primary	*Secondary*		*Primary*	*Secondary*		*Primary*	*Secondary*
Number	32	32	Knowing	42	25	Novice	29	18
Geometry	26	29	Applying	33	38	Intermediate	31	46
Algebra	25	22	Reasoning	15	24	Advanced	30	23
Data	7	4						
Total	90	87		90	87		90	87

For both the primary and lower-secondary levels, the largest number of items measuring MCK was classified as items pertaining to the intermediate curriculum level. About 68 percent of the items in the primary pool were classified at either the novice or intermediate level, and about 74 percent of the items in the secondary pool related to these two levels. Exhibit 3.10 shows the number of items in the final instruments for each MPCK domain. The limited number of items in the mathematics pedagogy subdomains of curriculum (primary) and planning (secondary) reflects the reporting decision mentioned above, that is, to combine these two into one subdomain.

Exhibit 3.10: Distribution of the MPCK items across the mathematics pedagogy subdomains

Subdomain	Number of Items	
	Primary	*Secondary*
Curriculum	6	9
Planning	11	4
Enacting	17	16
Total	34	29

3.2.9.1 Item formats

TEDS-M used three item formats—multiple-choice (MC), complex multiple-choice (CMC), and constructed-response (CR) to assess both MCK and MPCK. MC and CMC employ closed responses, whereas CR items require open responses. Exhibit 3.11 shows how many of the three different item formats were used to assess each dimension of mathematical knowledge for teaching.[1]

Exhibit 3.11: Distribution of item formats by subdomain in both primary and lower-secondary TEDS-M instruments

	Number of Items *Primary*			Number of Items *Secondary*		
Item Format	MCK	MPCK	Total	MCK	MPCK	Total
MC	23	6	29	10	4	14
CMC	62	14	76	64	23	87
CR	5	14	19	13	2	15
Total	90	34	124	87	29	116

3.3 Scoring the Assessment Items

Responses to the multiple-choice items and each part of the complex multiple-choice items received one point if correct and no (0) points if incorrect. Scoring the constructed-response items was based on the methodology developed for IEA's Trends in International Mathematics and Science Study. A description of this method along with the process used to develop the scoring guide and the scoring training materials and procedures for these items follows.

3.3.1 General Method Used to Score the Constructed-Response Items

Depending on the degree of complexity that they involved, the TEDS-M constructed-response (CR) mathematics and mathematics pedagogy items were given either one or two points for fully correct answers.

- One-point CR items were scored as correct (1 score point) or incorrect (0 score points).
- Two-point CR items were scored as fully correct (2 score points), partially correct (1 score point), or incorrect (0 score points). For example, a response to a MCK item containing an incorrect solution but a mathematically appropriate reasoning and procedure received partial credit. A response to a MPCK item that was incomplete or lacking some clarity was awarded partial credit.

In addition to differentiating between correct and incorrect answers, the design of the scoring system meant that information could be collected on what the participating future teachers knew and were able to do. Information sought included common approaches to solving problems and addressing common misconceptions. The diagnostic scoring system for CR items used two digits to categorize each response. The first digit was the score indicating the degree of correctness of the response: 2 for a two-point response, 1 for a one-point response, and 7 for an incorrect response. The second digit, combined

1 Please note that each part of a complex multiple-choice item was counted as one item. Complex multiple-choice items are closed items consisting of several parts. Each part must be answered. For an example, see the released item set MFC202A-D (from the primary item pool) in Brese and Tatto (2012).

with the first, was used to classify the method that the future teachers employed to solve a problem, or it was used to track common errors or misconceptions. The information from the second digit referenced questions of interest to TEDS-M such as these:

- Do approaches that lead to correct responses to the item vary across countries?
- Is there one approach that future teachers have more success with than others?
- What common misconceptions do future teachers have about the matter being tested?
- What common errors are made?

Scorers could use the second digit from within the range of 0 to 5 for predefined international codes at each correctness level. A second digit of 9 corresponded to "other" types of responses that fell within the appropriate correctness level but did not fit any of the predefined international codes. A special code (99) was given for completely blank responses. Examples of these scoring guides can be seen in the TEDS-M released item set (Brese & Tatto, 2012). Exhibit 3.12 provides a generic example of a double-digit scoring guide for a two-point CR item.

Exhibit 3.12: Example of generic double-digit scoring guide used for constructed-response items

Code	Response
	Correct Response
20	Correct response Type 1
21	Correct response Type 2
…	…
29	Other correct
	Partially Correct Response
10	Partially correct response Type 1
11	Partially correct response Type 2
…	…
19	Other partially correct
	Incorrect Response
70	Incorrect response Type 1
71	Incorrect response Type 2
…	…
79	Other incorrect (including crossed out, erased, stray marks, illegible, or off task)
	Nonresponse
99	Blank

3.3.2 Developing the Scoring Guides

The TEDS-M research teams developed the scoring guides for the field-trial CR items after investigating the responses of future teachers to pilots containing limited numbers of items and conducted in Australia, Botswana, Chile, Chinese Taipei, Philippines, and the United States. Selected student responses from the pilots were included as examples in the scoring guides and materials that were used to train scorers during the field trial.

The field trial results, including psychometric analyses, indicated the need for some revisions to the scoring guides that were to be used in the main study. Feedback from the NRCs based on their scoring experiences during the field trial also informed improvements to the scoring guides. In addition, sets of student responses from the field trial were collected from English-speaking field-trial countries as sources of sample student responses that could be used to clarify codes and prepare the scoring training materials for the main study. In order to add diversity to these materials, the non-English-speaking countries participating in TEDS-M were invited to translate sample students' responses into English and to send these on to the international study centers.

3.3.2.1 Scoring training materials and procedures

TEDS-M used a "train-the-trainers" approach to providing training on the international procedures for scoring the TEDS-M CR items. NRCs and/or other personnel responsible for training scorers in each country participated in the training sessions for the field trial and main survey. The national representatives at these sessions suggested a few additional revisions and clarifications. These were incorporated into the guides prior to their general distribution.

During each of these sessions, those attending reviewed the general TEDS-M scoring approach, and the trainee scorers received training on a subset of CR items. The subset of items selected reflected a range of the types of scoring and scoring situations encountered across the TEDS-M items. They also related to some of the most complicated scoring guides. To expedite training, participants received the international version of the scoring guides and a binder containing a set of prescored future-teacher responses. These illustrated the diagnostic codes and the rationale used to score the responses, as well as a set of 5 to 10 unscored practice responses for each item. The future teachers' responses were selected from the item-pilot and field-trial booklets.

The purpose of the international scoring training was to present a model for use in each country and an opportunity to practice and resolve the scoring issues associated with the most difficult items. The training teams discussed the need for NRCs to prepare comparable materials for training in their own country for all CR items and to have on hand a larger number of practice responses for the more challenging scoring guides during the national training sessions. The following general procedure was followed during the scoring training for each item:

- Participants read the item and its scoring guide.
- Trainers discussed the rationale behind and the methodology of the scoring guide.
- Trainers presented and discussed the set of prescored example future-teacher responses.
- Participants scored the set of practice future-teacher responses.
- Trainers led a group discussion of the scores given to the practice responses in order to reach a common understanding of the interpretation and application of the scoring guide.

At the end of the training sessions, the NRCs were given the example and practice papers along with their associated coding sheets and were asked to use these during scoring training in their own countries.

3.3.2.2 Scoring reliability

To establish scoring reliability, up to 760 of the booklets (380 primary and 380 lower-secondary) completed by future teachers during the main study were assigned for reliability scoring. Two different scorers independently scored the booklets; neither saw the other's scores. This approach is known as double "blind" scoring.

During the scoring of the national sets of booklets completed by future teachers, duos of scorers maintained blind scoring by having one person write down his or her scores on a separate scoring sheet and the other person write his or her scores in the booklet. There was one scoring sheet for each survey booklet. The two sets of scores were compared and the percentage of agreement between scorers in each country calculated. Agreement above 85 percent was considered good; between 70 percent and 85 percent was deemed acceptable, and below 70 percent was seen as a concern.

In general, countries were able to apply the scoring guides for the CR items with high reliability. For 89.5 percent of the items on the primary forms and for 100 percent of the items on the lower-secondary forms, the international reliability averages were greater than 85 percent.

3.3.3 Item Release Policy

The ISCs decided to release approximately one third of the items to the public and to keep the other two-thirds secure for possible use in future research studies. The items are included in Brese and Tatto (2012).

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CHAPTER 4:

DEVELOPMENT OF THE TEDS-M SURVEY QUESTIONNAIRES

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4.1 Overview

The TEDS-M research team developed four survey questionnaires:

- The future teachers' questionnaire (FTQ) for teachers in primary preparation programs, which also included an assessment of mathematics knowledge for teaching at the primary levels;
- The future teachers' questionnaire for teachers in secondary preparation programs, which also included an assessment of mathematics knowledge for teaching at the secondary levels;
- The educators' questionnaire (EQ); and
- The institutional program questionnaire (IPQ).

In this chapter we describe the purpose and content of the questionnaires, the process for their development, and the main constructs underlying the questionnaire items. Part C of the FTQ, containing items assessing future teachers' knowledge of mathematics and mathematics pedagogy, is described in detail in Chapter 3 of the report. The entire set of questionnaires is available as an appendix to the user guide for the TEDS-M international database (Brese & Tatto, 2012).

4.2 Development of the TEDS-M Survey Questionnaires

The international study centers (ISCs) at Michigan State University (MSU) and the Australian Council for Educational Research (ACER) led the design and development of the TEDS-M survey questionnaires in collaboration with the national research coordinators (NRCs) of the participating countries, and other experts. The surveys were piloted in 2005 and field trialed in 2006 (see Chapter 3 of this report). Exhibits 4.1 and 4.2 provide information relating to the variables that the researchers wanted the questionnaires to capture and the relationships they wanted to explore.

The TEDS-M survey design allowed multilevel analysis at the individual (future teacher) and at the teacher education program level. The questionnaires were designed to be consistent with one another in terms of design, layout, question format, and wording. Parallel questions were used across the questionnaires to measure the same constructs from different sources. We describe and discuss each questionnaire in the following sections.

Exhibit 4.1: Mapping the processes and outcomes of mathematics teacher preparation using the data collected from the TEDS-M surveys [a]

National Context	Program Structure	Program Process	Program Outcomes
1. *Policy, education, social and economic context* 2. *Regulatory framework* (e.g., requirements set by national or state registration bodies for entry, methods of course assessment and accreditation, graduation and registration) 3. *Labor market for teachers* (i.e., supply and demand for teachers) • Sources of recruits (teacher education, career changers, overseas, etc.) • Relative salaries and working conditions for teachers • Age profile of teachers • Retirement and resignation rates • Teacher skills needed to meet curriculum requirements	1. *Staffing profile/ experience* 2. *Methods of selection* 3. *Internal quality assurance process* 4. *Entry levels, degree of selectivity* 5. *Funding policies/allocation of funds/course costs*	1. *Structure* (e.g., concurrent undergraduate, postgraduate, etc.) 2. *Opportunity to learn* (e.g., content to be taught, pedagogical content knowledge, practice of teaching, planning, assessment, feedback, reflection, etc.) 3. *Course quality* (e.g., course coherence, links between theory and practice, quality of teaching, etc.) 4. *Practicum arrangements* (e.g., length, scheduling, nature, quality of supervision/feedback/ assessment, strength of partnership between teacher education institution and schools, etc.) 5. *Student intake* (e.g., prior achievement, subject background, prior careers, etc.)	1. *Surveys of teacher knowledge and beliefs* (measures of teachers' beliefs, mathematics knowledge, and mathematics pedagogical content knowledge) 2. *Survey of perceived preparedness*

Note: a The TEDS-M framework (Tatto et al., 2008) provides explicit definitions of the TEDS-M concepts and terminology.

4.2.1 The Future Teacher Questionnaires (FTQs)

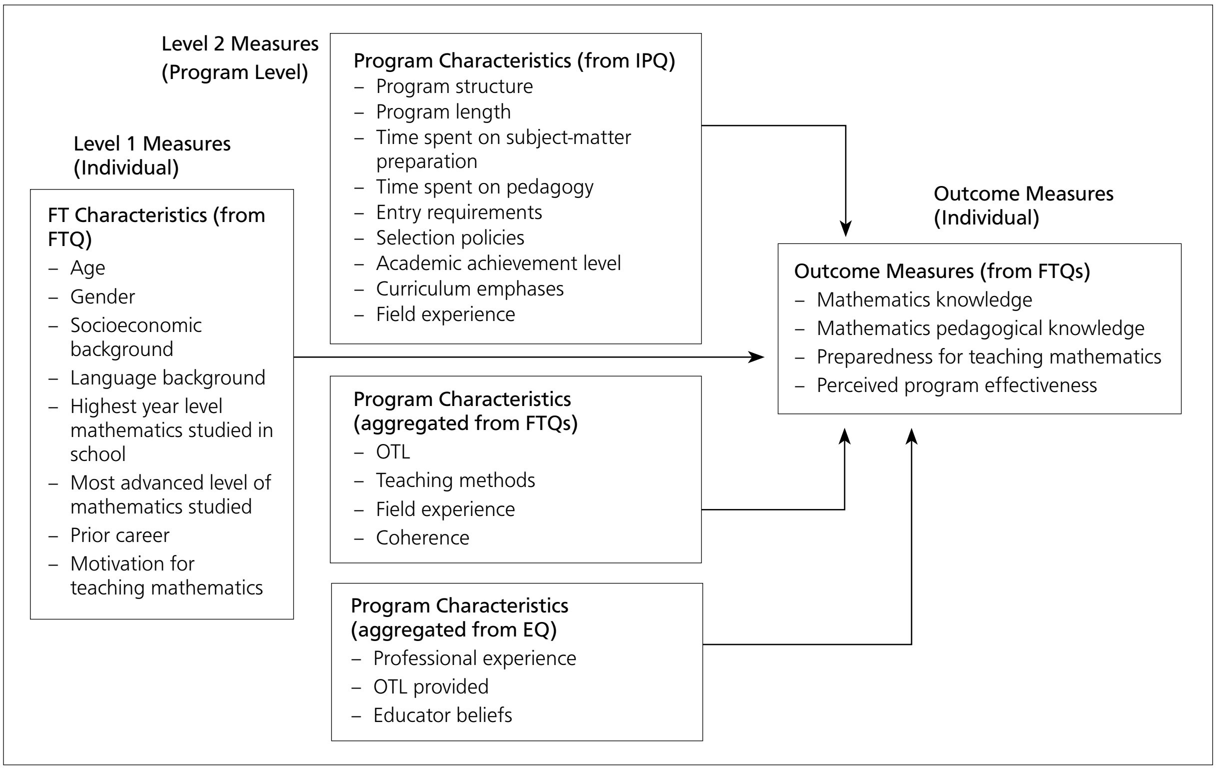
In addition to questions designed to measure future teachers' knowledge of mathematics and mathematics pedagogy, the future teacher questionnaires for the primary and secondary levels included questions on (1) general background, (2) program learning opportunities, and (3) beliefs about teaching and learning mathematics.

4.2.1.1 Part A: Background

The FTQs included a number of indicators of the future teachers' backgrounds and demographics. These indicators, which related to the variables that the TEDS-M team wanted to address during the data analysis, are listed below and set out in more detail in Exhibit 4.3. They were:

- Age, gender, parents' education/socioeconomic status, language spoken at home;
- Nature and level of secondary school mathematics knowledge;
- Academic/general education, area of specialization, routes into teaching, degrees obtained;
- Teaching/work experience, motivation/plans/intention with respect to becoming a mathematics teacher, special circumstances/personal costs of becoming a teacher, and how long the future teacher planned to stay in the profession.

Exhibit 4.2: TEDS-M research model for the TEDS-M surveys



4.2.1.2 Part B: Opportunities to learn

TEDS-M considered the concept of opportunity to learn (OTL) integral to explaining the impact of teacher preparation on teacher learning. The FTQs therefore included a number of items and scales developed to allow exploration of several types of OTL experienced by the future teachers both before and during their teacher preparation programs (see also Exhibit 4.4):

- *OTL tertiary-level mathematics:* The items in this part of the questionnaire were designed to determine whether the future teachers had studied key mathematics topics at tertiary level (e.g., geometry-related topics, algebra, number theory, calculus, functions, etc.). Because opportunities to learn in this area can occur either before future teachers enter teacher preparation (i.e., the consecutive programs) or during teacher preparation (in concurrent programs), these questions asked future teachers whether they had ever studied such topics. The mathematics domains covered were:
  - Continuity and functions (e.g., beginning calculus, calculus, multivariate calculus, advanced calculus or real analysis, and differential equations);
  - Discrete structures and logic (e.g., linear algebra, set theory, abstract algebra, number theory, discrete mathematics, and mathematical logic);
  - Geometry (e.g., foundations of geometry or axiomatic geometry, analytic or coordinate geometry, non-Euclidean geometry, and differential geometry); and
  - Probability and statistics (e.g., probability and theoretical or applied statistics).
- *OTL school-level mathematics:* This section contained items designed to allow exploration of the interaction between mathematics content and mathematics pedagogy within the contexts of the secondary school curriculum, techniques for teaching mathematics topics at this level of the education system, and student

Exhibit 4.3: Content of future teacher questionnaire, Part A: General background

Part A Item Content	Item Number	Description
General background	1	Age.
	2	Gender.
	3	The number of books in <future teacher's>, <parents', or guardian's home. The question consisted of four options for the number of books (ranging from "0–10 books" to "more than 200 books").
	4	The possession of specified items in <parents' or guardian's> home. The question listed eight common items and three country-specific items.
	5	The highest educational attainment by <future teacher's> mother or female guardian. The question consisted of eight academic categories.
	6	The highest educational attainment by <future teacher's> father or male guardian. The question consisted of eight academic categories.
	7	The frequency of speaking the language used for testing at home. The response options ranged from "always" to "never".
	8(a)	The highest grade level at which <future teacher> studied mathematics in <secondary school>.
	8(b)	The most advanced mathematics course in <secondary school>.
	9	The level of grades that <future teacher> received during his/her secondary schooling.
	10	Whether <future teacher> had another career before commencing his/her teacher education program.
	11	Reason for becoming a teacher. The question consisted of nine possible reasons. Each <future teacher> rated the significance of the reason to become a teacher.
	12	The circumstances—if any—hindering studies during the teacher education program (such as family responsibility, borrowing money, or having a job).
	13	<Future teacher's> perception of his/her future in teaching.

Note: Carets (< >) denote information to be replaced with the nationally-appropriate term.

learning. This area also included items regarding the depth of mathematics learning (e.g., at the level of the secondary school curriculum or at a deeper level beyond the school curriculum and with no relation to it). The mathematics domains covered included:

– Numbers (e.g., whole numbers, fractions, decimals, integers, rational and real numbers, number concepts, number theory, estimation, ratio, and proportionality);
– Measurement (e.g., measurement units, computations and properties of length, perimeter and area, and volume estimation and error);
– Geometry (e.g., one-dimensional and two-dimensional coordinate geometry, Euclidean geometry, transformational geometry, congruence and similarity, constructions with straightedge and compass, three-dimensional geometry, and vector geometry).

The domains pertaining to mathematics taught at the upper-secondary school level were:

– Data representation, probability, and statistics;
– Calculus (e.g., infinite processes, change, differentiation, integration);
– Functions, relations, and equations (e.g., algebra, trigonometry, analytic geometry); and
– Validation, structuring, and abstracting (e.g., Boolean algebra, mathematical induction, logical connectives, sets, groups, fields, linear space, isomorphism, homomorphism).

Exhibit 4.4: Content of future teacher questionnaire, Part B: Opportunities to learn

Part B Item Content	Item Number	Description
Opportunities to learn: *University or tertiary-level mathematics*	1	<Future teachers> were asked to indicate whether or not they studied each of the following 19 university-level mathematic topics during their teacher education program: • Foundations of geometry or axiomatic geometry • Analytic/coordinate geometry • Non-Euclidean geometry • Differential geometry • Topology • Linear algebra • Set theory • Abstract algebra • Number theory • Beginning calculus • Calculus • Multivariate calculus • Advanced calculus or real analysis or measure theory • Differential equations • Theory of real functions and theory of complex functions or functional analysis • Discrete mathematics, graph theory, game theory, combinatorics, or Boolean algebra • Probability • Theoretical or applied statistics • Mathematical logic.
Opportunities to learn: *School-level mathematics*	2	<Future teachers> were asked to indicate whether or not they studied each of the following seven topics during their teacher education program: • Numbers • Measurement • Geometry • Functions, relations, and equations • Data representation, probability, and statistics • Calculus • Validation, structuring, and abstracting.
	3	<Future teachers> were asked to indicate the level (i.e., school-level curriculum, more conceptual level than the school curriculum, and/or beyond the school curriculum) of emphasis given to learning mathematics during their teacher education program.
Opportunities to learn: *Mathematics education*	4	<Future teachers> were asked to indicate whether or not they studied each of the following eight topics during their teacher education program: • Foundations of mathematics • Context of mathematics education • Development of mathematics ability and thinking • Mathematics instruction • Developing teaching plans • Mathematics teaching: observation, analysis, and reflection • Mathematics standards and curriculum • Affective issues in mathematics.

Exhibit 4.4: Content of future teacher questionnaire, Part B: Opportunities to learn (contd.)

Part B Item Content	Item Number	Description
Opportunities to learn: *Mathematics education (contd.)*	5	<Future teachers> were asked to respond to statements about the frequency (responses ranging from “never” to “often”) with which they experienced the following activities during their teacher education program: • Listening to lectures • Asking questions during class time • Participating in a whole-classroom discussion • Making presentations • Teaching a class session using methods of own choice and using the methods demonstrated by the instructor • Working in groups • Reading research on mathematics, mathematics education, and/or teaching and learning • Analyzing teaching examples • Writing mathematical proofs • Problem-solving with respect to applied mathematics • Providing multiple strategies to solve a problem • Using computer and calculator.
	6	<Future teachers> were asked to indicate how frequently (responses ranging from ”never” to “often”) they engaged in each of the following activities during their teacher education program: • Accommodated a wide range of students’ abilities • Analyzed students’ assessment data • Analyzed/used national or state standards or frameworks for school mathematics • Assessed high- and low-level goals • Built on students’ existing mathematics knowledge and thinking skills • Created experiences that made clear the central concepts of the subject matter • Created projects that motivate all students to participate • Dealt with learning difficulties • Developed activities with high-interest level • Developed instructional materials that build on students’ experiences • Explored mathematics as the source for real-world problems • Explored the method of applying mathematics to real-world problems • Gave appropriate feedback to students about their learning • Helped students self-assess their learning • Used assessment to give feedback to parents, guardians, and students • Learned the method of exploring multiple-solution strategies • Learned the method of integrating mathematics ideas • Learned the method of making distinctions between procedural and conceptual knowledge • Learned the method of showing why a mathematics procedure works • Located appropriate curriculum materials • Used classroom assessment to guide instructional decisions • Used concrete materials to solve mathematics problems • Used standardized assessment to guide instructional decisions • Used students’ misconceptions to plan instruction.

Exhibit 4.4: Content of future teacher questionnaire, Part B: Opportunities to learn (contd.)

Part B Item Content	Item Number	Description
Opportunities to learn: *Education and <pedagogy>*	7	<Future teachers> were asked to indicate whether or not they studied each of the following topics during their teacher education program: • History of education and educational systems • Philosophy of education • Sociology of education • Educational psychology • Theories of schooling • Methods of educational research • Assessment and measurement • Knowledge of teaching.
Opportunities to learn: *Teaching for diversity and reflection on practice*	8	<Future teachers> were asked to indicate whether or not they had opportunity to learn each of the following specific skills/strategies related to teaching students with diverse backgrounds during their teacher education program: • Teaching students with behavioral/emotional problems • Teaching students with learning disabilities • Teaching gifted studies • Teaching students from diverse cultural backgrounds • Accommodating the needs of students with physical disabilities • Working with students from disadvantaged backgrounds • Teaching standards and codes of conduct • Reflecting on the effectiveness of their own teaching • Reflecting on their own professional knowledge • Identifying their own learning needs.
	9	<Future teachers> were asked whether or not they learned how to enhance each of their own following listed instruction and teaching skills during their teacher education program: • Stages of child development and learning • The method of developing research projects to test teaching strategies • The relationships between education, social justice, and democracy • New teaching practices by observing teachers • The method of developing/testing new teaching practices • The method of setting appropriate learning expectations for students • The application of research findings to improve knowledge and practice • The method of connecting learning across subject areas • Ethical standards and codes of conduct • Methods of enhancing students' confidence and self-esteem • Changing schooling practices • Finding appropriate resources for teaching.
Opportunities to learn: *School experience and the field experience/ practicum*	10[a]	<Future teachers> were asked whether or not they spent time in a <primary/secondary school> during their <field experience>.
	11	Future teachers were asked to specify the proportion of time that they were in charge of teaching the class during their field experience. The response range was "(a) less than one quarter of the time," "(b) a quarter or more, but less than half," "(c) half or more, but less than three quarters," "(d) three quarters or more."
	12	Future teachers were asked to specify the proportion of time that assigned <mentors/ instructors/supervisors> were present in the same classroom as them during their field experience.
	13	<Future teachers> were asked to indicate the frequency (response options were "never," "rarely," "occasionally," "often") with which they experienced each of the following listed activities during their field experience: • Observing modeling of teaching strategies • Putting into practice theories for teaching mathematics • Completing assessment tasks that required them to apply ideas they learned during their coursework • Receiving feedback on their implementation of teaching strategies • Collecting and analyzing evidence about student learning • Testing findings from educational research • Developing strategies to reflect on their own professional knowledge • Demonstrating the application of teaching methods learned during coursework.

Exhibit 4.4: Content of future teacher questionnaire, Part B: Opportunities to learn (contd.)

Part B Item Content	Item Number	Description
Opportunities to learn: *School experience and the field experience/ practicum (contd.)*	14	<Future teachers> were asked to rate their level of agreement (responses ranging from "disagree" to "agree") with each of the following statements pertaining to experiences during their teacher education program: • <Future teacher> had a clear understanding of what a school-based <supervising teacher> expected of him/her in order to pass the <field experience> • The school-based <supervising teacher> valued the ideas and approaches the <future teacher> brought from his/her teacher education program • The school-based <supervising teacher> used criteria/standards provided by a university when reviewing lessons with <future teacher> • <Future teacher> learned the same criteria or standards for good teaching during his/her teacher education coursework and <field experience> • Future teacher in his/her <field experience/practicum> had to demonstrate that he/she could teach according to the same criteria/standards used in his/her <university/college> courses • The feedback <future teacher> received from a school-based <supervising teacher> that helped him/her improve his/her understanding of students • The feedback <future teacher> received from a school-based <supervising teacher> that helped him/her improve his/her understanding of teaching methods • The feedback <future teacher> received from a school-based <supervising teacher> that helped him/her improve his/her understanding of students, teaching methods, and the curriculum • The feedback <future teacher> received from a school-based <supervising teacher> that helped him/her improve his/her knowledge of mathematics content • The teaching methods <future teacher> used during his/her <field experiences> were quite different from the methods he/she learned during the teacher preparation program • The regular supervising teacher in the <future teacher's> <field-experience> classroom taught in ways that differed markedly from the methods the <future teacher> learned during his/her teacher education program.
Coherence of the teacher education program	15	<Future teachers> were asked to state whether they agreed or not with each of the following statements designed to gauge their opinion of the coherence of their teacher preparation program: • The coherence between the teacher education program and <future teachers'> main needs • The consistency of courses in the program • The coherence between the program's organization and preparing effective teachers • The logical sequence of program development in terms of content and topics covered by courses • The coherence of the program with respect to providing explicit standards expectations for beginning teachers • The clarity of links between the courses in the program.

Notes:

Carets (< >) denote information to be replaced with the nationally-appropriate term.

a If a <future teacher> did not have any field experience, he or she was asked to skip Questions 11 to 14 and answer Question 15.

- *OTL mathematics education/pedagogy:* This section included items designed to allow exploration of the interaction between mathematics content and pedagogy. Additional scales included items about learning strategies in mathematics. Future teachers were asked to indicate whether or not they had studied each topic as part of their teacher preparation program. Other questions asked them how often they had engaged in a number of activities and learning strategies during their teacher preparation program.
- *OTL general knowledge for teaching:* These items focused on topics considered relevant for all teachers to know, such as educational theory, general principles of instruction, classroom management, curriculum theory, and so on. These items asked future teachers whether they had studied such topics during their teacher preparation program.
- *OTL teaching for diversity and reflection on practice:* The items included ones about developing and using materials for teaching as well as items about accommodating diverse levels of student learning. Additional items explored learning how to assess and reflect on one's own teaching and develop strategies to improve one's own professional knowledge.
- *OTL school experience and the practicum:* These items asked future teachers more indepth questions about their school-based (field, practicum) experience in terms of whether they had spent time in the classroom in a primary or secondary school and, if so, for how long; whether a school supervisor had been assigned to them; the particular activities in which they had been engaged and at what levels; and whether they found the experience helpful. An additional set of questions asked about diverse characteristics of the practicum (e.g., the role of the mentor, feedback received, standards, methods used, and level of mathematics knowledge and pedagogy of the classroom teacher or mentor).
- *OTL in a coherent program:* The items included here were designed to allow exploration of program consistency across the courses and experiences offered to future teachers, and whether their program had explicit standards with respect to what they should learn from it.

4.2.1.3 Part C: Mathematics knowledge for teaching

TEDS-M measured the intended and achieved knowledge of mathematics and mathematics pedagogy of future teachers in their last year of the sampled teacher education programs. As described in Chapter 3, the items used to measure this area of future teacher knowledge built on the Mathematics Teaching for the 21st Century (MT21) study (Schmidt et al., 2007), which employed an earlier and shortened version of this part of the FTQ.

4.2.1.4 Part D: Beliefs

The aim of the questions included in this part of the questionnaire was to elicit information that would help determine whether teacher preparation can positively influence future teachers' beliefs about what they teach and how they teach or whether these beliefs are an intrinsic characteristic of those individuals who become teachers (Tatto & Coupland, 2003). In TEDS-M 2008, this measurement area was informed by work related to the Teaching and Learning to Teach study at MSU (Deng, 1995; Tatto, 1996, 1998, 1999, 2003), and by work of other international scholars such as Grigutsch, Raatz, and Törner (1998), Ingvarson, Beavis, Danielson, Ellis, and Elliott (2005), and Ingvarson, Beavis, and Kleinhenz (2007).

The TEDS-M beliefs scales encompassed five categories of belief (see also Exhibit 4.5):

- *The nature of mathematics:* These questions, which asked future teachers to indicate their perceptions of mathematics as a subject (e.g., mathematics as formal, structural, procedural, or applied) were based on work by Grigutsch et al. (1998) and Ingvarson et al. (2005, 2007). The items under this beliefs category formed two distinct scales—mathematics as a set of rules and procedures, and mathematics as a process of enquiry.
- *Learning mathematics:* These questions focused on the appropriateness of particular instructional activities, school students' cognition processes, and the purposes of mathematics as a school subject. The 14 items on beliefs about learning mathematics formed two distinct scales—learning mathematics through reliance on the teacher, and learning mathematics through self-reliance.
- *Mathematics achievement:* The eight items in this section of the questionnaire tapped into future teachers' beliefs about various teaching strategies used to facilitate mathematics learning, how mathematics learning takes place, and the application of attribution theory to teaching and learning interactions (e.g., innate ability for learning mathematics). The items used to measure these areas came from a number of studies, including those by Deng (1995), the MT21 study (Schmidt, Blömeke, & Tatto, 2011), and several studies by Tatto (1996, 1998, 1999, 2003). The items formed two scales. The first embraced the notion that achievement in mathematics depends largely on children's fixed ability. The second held to the premise that achievement in mathematics depends largely on children's efforts to learn.
- *Preparedness for teaching mathematics:* The questions asked in relation to this belief concerned the extent to which future teachers perceived their teacher preparation had given them the capacity to carry out the central tasks of teaching and to meet the demands of their first year of practice. The items in this area were therefore designed to explore different dimensions of the impact of teacher preparation on preparedness to teach. The preparedness items used in TEDS-M came from ACER's Preparedness to Teach inventory, a robust measure based on extensive research by Ingvarson and colleagues (2005, 2007). The items focused on preparedness to (amongst other skills) conduct assessment, manage learning environments, and engage students in effective learning. Questions designed to measure the extent to which the future teachers felt they had become active members of their professional community were also included.
- *Program effectiveness:* These questions asked future teachers to indicate how well, overall, they thought their teacher preparation had been in helping them learn to teach mathematics. Questions probed future teachers' beliefs about the degree to which their instructors modeled good teaching practices and used and promoted research, evaluation, and reflection in their courses. The questions also asked the future teachers if their instructors valued future teachers' various experiences before and during their teacher preparation program.

Exhibit 4.5: Content of future teacher questionnaire, Part D: Beliefs

Part D Item Content	Item Number	Description
Beliefs about the nature of mathematics	1	<Future teachers> were asked to state whether or not they agreed with each of the following (abbreviated) statements regarding beliefs about the nature of mathematics: • Mathematics is a collection of rules and procedures that describe how to solve a problem • Mathematics involves the remembering and application of definitions, formulas, mathematical facts, and procedures • Mathematics involves creativity and new ideas • When doing mathematics, you can discover and try out many things by yourself • When solving mathematical tasks, you need to know the correct procedure • If you engage in mathematics tasks, you can discover new things (connections, rules, concepts) • Logical rigor and precision are fundamental to mathematics • Mathematical problems can be solved correctly in many ways • Many aspects of mathematics have practical relevance • Mathematics help us solve everyday problems and tasks • Doing mathematics requires considerable practice, correct application of routines, and problem-solving strategies • Mathematics means learning, remembering, and applying.
Beliefs about learning mathematics	2	<Future teachers> were asked to state whether or not they agreed with statements reflecting beliefs about learning mathematics. The statements focused on the following: • The best way of doing well in mathematics • Whether or not students need to be taught • The importance of having understood the mathematical problem even when one has got the answer right • Methods of being good at mathematics • The best way to learn mathematics • The aspect of learning given emphasis when students are working on mathematics problems • The importance of understanding the reason for the correct answer • The importance of figuring out the method of solving mathematical problems • Nonstandard procedures for solving problems • The value of hands-on mathematics experiences • The value of the time used to investigate the reason for a solution • The need for teachers to help students solve mathematical problems • The need for teachers to encourage students to find their own solutions • Discussion of different ways of solving particular problems.
Beliefs about mathematics achievement	3	<Future teachers> were asked to state whether they agreed or not with statements reflecting beliefs about mathematics achievement. The statements focused on the following: • The use of hands-on models and other visual aids for older students • Being good at mathematics • The importance of natural ability and effort in mathematics • Participation in multi-step problem-solving activities • Gender differences in mathematics • The persistence of mathematical ability • Being good at mathematics • Ethnicity and mathematics ability.

Exhibit 4.5: Content of future teacher questionnaire, Part D: Beliefs (contd.)

Part D Item Content	Item Number	Description
Beliefs about preparedness for teaching mathematics	4	<Future teachers> were asked to state how well prepared they believed they were (response options "not at all," "a minor extent," "a moderate extent," "a major extent") to carry out the following activities: • Communicate ideas and information about mathematics • Establish appropriate learning goals in mathematics • Set up mathematics learning activities • Use questions to promote higher-order thinking • Use computers and ICT to aid the teaching of mathematics • Encourage students to engage in critical thinking about mathematics • Use assessment to give effective feedback • Provide parents/guardians with useful information about their child's progress • Develop assessment tasks that promote learning in mathematics • Incorporate effective classroom management strategies into teaching • Have a positive influence on difficult students • Work collaboratively with other teachers.
Beliefs about program effectiveness	5	<Future teachers> were asked to state their level of agreement (responses ranging from "strongly disagree" to "strongly agree") with statements about the effectiveness of their program instructors. Three of the statements focused on the instructors': • Teaching practice • Use of research relevant to the content of their courses • Evaluation and reflection. The remaining three asked <future teachers> about the following: • The value of their learning and experiences prior to the teacher preparation program • The value of their learning and experiences during field experience/practicum • The value of the learning and experiences during the teacher education program.
	6	<Future teachers> were asked to state how effective they believed their teacher education program overall was in preparing them to teach mathematics.

Note: Carets (< >) denote information to be replaced with the nationally-appropriate term.

4.2.2 The Educator Questionnaire (EQ)

TEDS-M conceptualized the educators of future mathematics teachers as particularly important individuals through whom the intended teacher education curriculum becomes the implemented curriculum. With that in mind, the TEDS-M researchers determined that the survey instrument should collect data on the educators' general backgrounds and key aspects of the OTL they provided to the future teachers in their respective programs. The questionnaire also asked the educators to answer questions about their beliefs relating to the same areas addressed in the FTQs so that the educators' responses could be compared with those of the future teachers.

4.2.2.1 Definition of educators of future teachers of mathematics

TEDS-M defined these educators as persons with regular, repeated responsibility for teaching future teachers of mathematics within a given teacher-preparation route and/or program. The study also classified these educators into three groups:

- *Mathematics and mathematics pedagogy educators:* Those educators responsible for teaching one or more of the program's required courses in mathematics or mathematics pedagogy during the study's data-collection year at any stage of the institution's teacher preparation program.
- *General pedagogy educators:* Those educators responsible for teaching one or more of the program's required courses in foundations or general pedagogy (other than a mathematics or mathematics pedagogy course) during the study's data-collection year at any stage of the institution's teacher preparation program.
- *Educators:* Those individuals belonging to both Groups 1 and 2 as described above and so responsible for teaching one or more of the program's required courses in mathematics and/or mathematics pedagogy and/or general pedagogy during the study's data-collection year at any stage of the institution's teacher preparation program.

4.2.2.2 Questionnaire content

The EQ asked mathematics, mathematics pedagogy, and general pedagogy educators of future teachers within the sample of teacher preparation institutions questions about, amongst other matters, their teaching background, professional and research experience, and the OTL they offered the students in their courses. Exhibit 4.6 details the areas covered by the questionnaire.

4.2.3 The Institutional Program Questionnaire (IPQ)

TEDS-M decided to conduct a survey of teacher preparation institutions in order to elicit the following:

- Data on institutional program characteristics that might differ from the characteristics in other institutions in the same teacher preparation route;
- Data pertaining to variables potentially influencing the measured outcomes of the study; and
- Data that could not feasibly be collected by other means.

Exhibit 4.6: Content of educator questionnaire

Part	Item Content	Item Number	Description
Part A	*General and academic backgrounds*	1	Current academic status.
		2	Gender.
		3	Highest educational qualification for six academic areas (i.e., mathematics, mathematics education, education, other mathematics-related discipline or field, and other discipline or field).
		4	Whether educator considered himself/herself a mathematics specialist.
		5	Whether educator held a <teaching certificate, license, or registration> to teach.
		6	Whether educator held a teaching position in a school.
Part B	*Teaching background*	1	Years of experience teaching in <primary> and/or <secondary> schools.
		2	Years of experience teaching mathematics in <primary> and/or <secondary> schools.
		3	Years of employment with current institution.
		4	Years of preparation for teaching <future teachers> who will teach at <primary> or <secondary> schools.
		5	The proportion of <future teachers> in the course that educator teaches.
		6	The level of the course that educator teaches.
Part C	*Professional experience*	1	Educators were asked to state whether and when (either prior to or after starting work, or never) they received special preparation for teaching.
		2	Educators were asked to state whether or not they had received professional training in the areas of mathematics, mathematics <pedagogy>, and/or general <pedagogy> during the last 12 months.
Part D	*Research experience*	1	Educators were asked to state whether or not they had research experience in the following areas: • Mathematics • Mathematics education or mathematics <pedagogy>, and/or • Other than mathematics <pedagogy>.
		2	Educators were asked to specify the percentage of working time (out of a total 100% for five listed options) that they had devoted over the previous 12 months to the activities: • Teaching • Research • Administration • <Service> to the profession • Other.
Part E	*Field-based instruction*	1[a]	Educators were asked to state if their role in <future teachers'> <practicum/field experience> included the following activities: • Observing <future teachers'> teaching • Providing advice • Assessing <future teachers'> teaching acumen.
		2	Educators were asked to state the length of time they spent instructing and/or supervising <future teachers> during their <practicum/field experience>.
Part F	*Opportunities to learn in educator's <course>* [b]		Educators were asked about the career objectives of the <future teachers> enrolled in their course. Educators were asked to specify the main subject covered by the course.

Exhibit 4.6: Content of educator questionnaire (contd.)

Part	Item Content	Item Number	Description
Part G [c]	*Opportunities for <future teachers> to learn mathematics and mathematics <pedagogy> during educator's <course>*	1	Educators were asked to state the level at which the <future teachers> in their course were learning mathematics: • Level of the school curriculum • A more conceptual level than the school curriculum, and/or • Beyond the school curriculum.
		2	Educators were asked to state whether or not the <future teachers> in their course had opportunities to learn each of the following specific skills or areas of knowledge during the course: • Use of national/state standards or framework for school mathematics • Methods of building on students' existing mathematics knowledge • Application of mathematics to real-world problems • Use of concrete materials to solve mathematics problems • Methods of exploring multiple solutions • Methods of showing why a mathematics procedure works • Methods of making distinctions between procedural and conceptual knowledge • Methods of integrating mathematics ideas.
Part H [d]	*Opportunities for <future teachers> to learn general <pedagogy> during educator's <course>*	1	Educators were asked to state whether or not the <future teachers> in their course had opportunities to learn each of the following skills or knowledge areas (aimed at enhancing <future teachers'> instruction and teaching skills) during the course: • Stages of child development and learning • Methods of developing research projects to test teaching strategies • Relationships between education, social justice, and democracy • New teaching practices through observing teachers • Methods of developing/testing new teaching practices • Methods of setting out learning expectations for students • Application of research findings to improve knowledge and practice • Methods of connecting learning across subject areas • Ethical standards and codes of conduct • Methods of enhancing students' confidence and self-esteem • Changing schooling practices • Finding appropriate resources for teaching.
		2	Educators were asked to state whether or not the <future teachers> in their course had opportunities to learn each of the following skills or knowledge areas relating to teaching students with diverse backgrounds: • Strategies for teaching students with behavioral/emotional problems • Strategies for teaching students with learning disabilities • Strategies for teaching gifted students • Strategies for teaching students from diverse cultural backgrounds • Accommodating the needs of students with physical disabilities • Working with students from disadvantaged backgrounds • Using teaching standards and codes of conduct • Reflecting on the effectiveness of their teaching • Reflecting on their professional knowledge • Strategies for identifying their own learning needs.

Exhibit 4.6: Content of educator questionnaire (contd.)

Part	Item Content	Item Number	Description
Part I	*Opportunities to learn during educator's <course>*	1	Educators were asked to state whether or not they expected the <future teachers> in their course to do each of the following activities: • Listen to a lecture • Ask questions • Participate in class discussions • Make presentations • Demonstrate teaching using <future teacher's> selected method • Demonstrate teaching using educator's selected method • Group work • Read research on mathematics, mathematics education, and/or teaching and learning • Analyze teaching examples • Write mathematical proofs • Problem-solve in relation to applied mathematics • Provide multiple strategies to solve a problem • Use computer and calculator.
		2	Educators were asked to state whether or not they required the <future teachers> in their course to do each of the following activities: • Observe modeling of teaching strategies • Practice theories for teaching subject-matter content • Conduct assessment • Provide feedback about their teaching • Evaluate their students' learning • Apply research findings on learning difficulties to their teaching practice • Use strategies to reflect on their professional knowledge • Demonstrate teaching methods.
		3	Educators were asked to state whether or not the <future teachers> in their course had opportunities to learn each of the following skills or knowledge areas during the course: • Accommodate a wide range of student ability • Analyze students' assessment data • Assess high- and low-level goals • Create experiences that make clear the central concepts of subject matter • Create projects that motivate all students to participate • Deal with learning difficulties • Develop activities with high-interest level • Develop instructional materials that build on students' experiences • Give students appropriate feedback • Help students self-assess their own learning • Locate appropriate curriculum materials • Use assessment to give feedback to parents, guardians, and students • Use classroom assessment to guide instructional decisions • Use students' misconceptions to plan instruction • Use standardized assessment to guide instructional decisions.
Part J [d]	*Coherence of the teacher education program*	1	Educators were asked to state the extent to which they agreed (four response options ranging from "disagree" to "agree") with statements about the coherence of the education program. The statements focused on the following: • The coherence of the teacher education program with <future teachers'> main needs • The consistency of courses in the program • The coherence between the program's organization and preparing effective teachers • The logical sequence of development in terms of the content and topics covered by the program's courses • The coherence between the program and the explicit standards expectations for beginning teachers • Clarity of the links across the program's courses.

Exhibit 4.6: Content of educator questionnaire (contd.)

Part	Item Content	Item Number	Description
Part K	*Beliefs about mathematics*	1	Educators were asked to state the extent to which they agreed (six response options ranging from "strongly disagree" to "strongly agree") with each of the following "abbreviated" statements reflecting beliefs about mathematics: • Mathematics is a collection of rules and procedures • Mathematics involves remembering and applying definitions, formulas, mathematical facts, and procedures • Mathematics involves creativity and new ideas • When doing mathematics, you can discover and try out many things by yourself • When solving mathematical tasks, you need to know the correct procedure • If you engage in mathematics tasks, you can discover new things • Logical rigor and precision is fundamental to mathematics • Mathematical problems can be solved correctly in many ways • Many aspects of mathematics have practical relevance • Mathematics helps us solve everyday problems and tasks • Doing mathematics requires considerable practice, correct application of routines, and problem-solving strategies • Mathematics means learning, remembering, and applying.
	Beliefs about learning mathematics	2	Educators were asked to state the extent to which they agreed (six response options ranging from "strongly disagree" to "strongly agree") with statements reflecting beliefs about mathematics. The statements focused on the following: • The best way of doing well in mathematics • Whether or not students need to be taught • The importance of having understood the mathematical problem even when one has got the answer right • Methods of being good at mathematics • The best way to learn mathematics • The aspect of learning given emphasis when students are working on mathematics problems • The importance of understanding the reason for the correct answer • The importance of figuring out the method of solving mathematical problems • Nonstandard procedures for solving problems • The value of hands-on mathematics experiences • The value of the time used to investigate the reason for a solution • The need for teachers to help students solve mathematical problems • The need for teachers to encourage students to find their own solutions • Discussion of different ways of solving particular problems.
	Beliefs about student achievement in <primary/secondary> mathematics	3	Educators were asked to state the extent to which they agreed (six response options ranging from "strongly disagree" to "strongly agree") with statements reflecting beliefs about student achievement in mathematics. The statements focused on the following: • The use of hands-on models and other visual aids for older students • Being good at mathematics • The importance of natural ability and effort in mathematics • Participation in multi-step problem-solving activities • Gender differences in mathematics • The persistence of mathematical ability • Being good at mathematics • Ethnicity and mathematics ability.

Exhibit 4.6: Content of educator questionnaire (contd.)

Part	Item Content	Item Number	Description
Part L	*Preparedness for teaching mathematics*	1	Educators were asked to state the extent to which they agreed (four response options ranging from "not at all" to "a major extent") with statements reflecting beliefs about the skills or knowledge areas <future teachers> should possess when they start their teaching career. The statements focused on the following: • Communicating ideas and information about mathematics • Establishing appropriate learning goals in mathematics • Setting up mathematics learning activities • Using questions to promote higher-order thinking • Using computers and ICT to aid the teaching of mathematics • Challenging students to engage in critical thinking about mathematics • Establishing a supportive environment for learning • Using assessment to give effective feedback • Providing parents and guardians with useful information about their child's progress • Developing assessment tasks that promote mathematics learning • Incorporating effective classroom management strategies into teaching • Having a positive influence on difficult students • Working collaboratively with other teachers.
		2	Educators were asked to state how effective they believed the teacher education program overall was in preparing teachers of mathematics.

Notes:

Carets (< >) denote information to be replaced with the nationally-appropriate term.

a If an educator did not fit any of the listed roles, he or she was asked to skip the next questions and move to Part F.

b Educators were asked to select one of the courses they taught when answering the questions in Part F.

c Only those educators whose selected course included mathematics content or mathematics <pedagogy> were requested to answer the Part G questions.

d Only those educators whose selected course included general <pedagogy> were asked to answer the Part H questions.

4.2.3.1 Definition of teacher preparation institutions

TEDS-M 2008 defined teacher preparation institutions as secondary or post-secondary schools/colleges/universities offering structured OTL (i.e., a program or programs) on a regular and frequent basis to future teachers within a route of teacher preparation. For the purposes of this questionnaire, the term "program" referred to the set of courses or units of study and other learning activities that constituted the formal preparation provided to future primary or lower-secondary teachers of mathematics. These were the programs (so-called teacher preparation units or TPUs) from which future teachers were recruited to complete the TEDS-M FTQs.

Eligible teacher education programs were concurrent, consecutive, and apprenticeship. TEDS-M defined a *concurrent* teacher preparation program as a single program that included studies in subjects future teachers would be teaching (academic or subject-matter preparation), studies of pedagogy and education (pedagogical and professional studies), and practical experience in the classroom. A *consecutive* teacher preparation program was defined as one that included pedagogical and professional studies and practical experience, preceded by a separate program for academic or subject-matter preparation (typically leading to a separate degree or diploma) that might or might not occur in the same institution. An *apprenticeship* teacher preparation program referred to a program consisting predominantly of school-based experience, with other institutions playing only a minor, marginal, or supporting role.

In order to secure confidentiality, TEDS-M determined that no findings arising out of the data collection would be reported for individual programs. All TEDS-M publications therefore refer to aggregate data.

4.2.3.2 Questionnaire content

The design of the IPQ took the form of a guided interview that could be conducted either in a face-to-face format with particular individuals, or within a focus-group session. It included questions about program description, future teacher background, selection policies, program content, field experience, program accountability and standards, staffing, program resources, and reflections on the program. Exhibit 4.7 provides more detail about the content of this questionnaire. It should be noted that many of the questions in this survey were covered by multiple items.

Exhibit 4.7: Content of institutional program questionnaire

Part	Item Content	Item Number	Description
Part A	*Program description*	1	This question asked if the program prepared <future teachers> to teach in primary schools, secondary schools, or both.
		2	This filter question asked if the program was concurrent, consecutive, or apprenticeship.
		3	For *concurrent programs*, the questions were: • How many years and months does it take for a typical <future teacher> to complete this program? • What credential is earned in this program? Please also enter ISCED level, using the chart at the beginning of this questionnaire.
		5–8	For *consecutive programs*, the questions were: • How many years and months does it take for a typical <future teacher> to complete this program? • Does this academic or subject-matter preparation take place in your institution? • How many years and months does it take for a typical <future teacher> to complete the <pedagogical> and professional studies (including practical experience) of this program? • What credential is earned at the end of the <pedagogical> and professional studies (including practical experience) of this program? Please also enter ISCED level, using the chart at the beginning of this questionnaire.
		9–12	For *apprenticeship programs*, the questions were: • How many years and months does it take for a typical <future teacher> to complete this program? • Is your training institution (other than the <primary> or <secondary> school in which the practical experience takes place) responsible for coordinating the learning program for <future teachers> during this apprenticeship program? • Who is responsible for the practical experience? • What credential is earned in this apprenticeship program? Please also enter ISCED level, using the chart at the beginning of this questionnaire.
Part B	*<Future teacher> background*	1a)	The minimum grade level of mathematics that <future teachers> are required to have completed in <secondary> school.
		1b)	The most advanced mathematics course that <future teachers> are required to have completed in <secondary> school.
		2	The minimum required qualification for entry into the program.
		3	The grade levels and the subject areas that the program prepares its <future teachers> to teach. Respondents were asked to indicate where the preparation was offered for each of the listed subject areas (i.e., mathematics, sciences, literacy, social studies, generalist, other) by grade level.

Exhibit 4.7: Content of institutional program questionnaire (contd.)

Part	Item Content	Item Number	Description
Part B *(contd.)*	*<Future teacher> background*	4	The number of fields that program graduates are normally qualified to teach.
		5	The proportion of parttime students during the first year of the program.
		6	The location where the program takes place.
		7	The number of <future teachers> who began or will begin the program. (Respondents were asked to report by year from 2003 to 2008.)
		8a)	The number of <future teachers> who successfully completed or will complete the program. (Respondents were asked to report by year from 2003 to 2008.)
		8b)	The number of <future teachers> who successfully completed or will complete the program with a qualification to teach mathematics. (Respondents were asked to report by year from 2003 to 2008.)
Part C	*Selection policies*	1	Who sets the admission policies for the program?
		2	The degree of importance of the listed information for the selection of <future teachers> for the program. The list of information included: • The overall level of attainment of their final year of <secondary schooling> measured by school marks • The overall level of performance of their final year of <secondary schooling> measured by a national/state examination • Performance on an examination for admission specially prepared by the institution • Stability for teaching • Level of mathematics achievement • Gender • Under-represented group in the teaching profession • The order of application • Region of residence • Age.
		3	Whether the institution has special strategies to attract <future teachers> into the program.
		4	The level of prior academic achievement of <future teachers> in the program with reference to national norms.
		5	Whether the program makes a special effort to attract fulltime workers with no previous experience of teaching.
		6	The proportion of previous fulltime employees among <future teachers> before they entered the program.
Part D	*Program content*	1	The website address for the program requirement.
		2	The program requirement.
		3	A: The required number of <liberal arts> courses for the duration of the program. B: The required number of teaching contact hours per <liberal arts> course.
		4	A: The required number of <academic mathematics> courses for the duration of the program. B: The required number of teaching contact hours per <academic mathematics> course.
		5	A: The required number of <mathematics content> courses for the duration of the program. B: The required number of teaching contact hours per <mathematics content> course.
		6	A: The required number of <mathematics pedagogy> courses for the duration of the program. B: The required number of teaching contact hours per <mathematics pedagogy> course.

Exhibit 4.7: Content of institutional program questionnaire (contd.)

Part	Item Content	Item Number	Description
Part D *(contd.)*	*<Future teacher> background*	7	A: The required number of professional foundation and theory courses for the duration of the program. B: The required number of teaching contact hours per professional foundations and theory course.
		8	A: The required number of general <pedagogy> courses for the duration of the program. B: The required number of teaching contact hours per general <pedagogy> course.
		9	The total number of required courses that <future teachers> needed to complete during the teacher preparation program.
		10	The attendance at scheduled <class time> by <future teachers>.
		11	The weight (ranging from "little or no weight" to "major weight") given to goals relating to: • Curriculum content knowledge • <Pedagogical> content knowledge • General <pedagogy>/educational foundations • Assessing learning • Knowledge of students and diversity • Preparation for further development as a teacher • Understanding the school environment.
		12	The institutional requirements to be met in order to successfully complete the program. The question listed eight common institutional requirements. For each of the listed requirements, respondents were asked to select either "Yes" or "No."
		13 [a]	Whether or not the program had a document setting out the competencies that <future teachers> needed to have in order to graduate from the program.
		14	The origin of the guideline on competencies.
Part E	*Field experience*	1 [b]	The type of field experience included in the program (i.e., extended teaching practice or introductory field experiences or both).
		2	The number of days that <future teachers> spend in school setting by year (from Year 1 to Year 5). Respondents were asked to specify the number of days and the average number of hours per day <future teachers> spend in (a) extended teaching practice and (b) introductory field experience.
		3 [c]	The frequency of the activities assigned as part of the introductory field experiences in the program. For each of the listed activities, respondents were asked to rate its occurrence during field experiences. The scale ranged from "not at all" to "usually." The list of activities included: • Planning lessons • Teaching individual lessons to whole classes • Tutoring individual students • Working with small groups of students • Assisting teachers • Assisting in school activities outside the assigned classroom • Carrying out case studies of selected students • Carrying out classroom observation • Collecting data for research projects • Visiting families in students' homes • Interviewing teachers • Observing teachers' meetings.
		4 [d]	The frequency with which teacher educator observed <future teachers>.
		5	Whether practicing teachers received compensation for supervising <future teachers>.
		6	Whether mathematics specialists had responsibility for supervising <future teachers> in the program.

Exhibit 4.7: Content of institutional program questionnaire (contd.)

Part	Item Content	Item Number	Description
Part E *(contd.)*	*Field experience*	7	The percentage of <future teachers> who gained a satisfactory result for their expended teaching practice.
		8	The policies regarding <future teachers'> unsatisfactory performance during their extended teaching practice.
		9	The assumed responsibilities of supervisors during extended teaching. The question covered five major responsibilities: • Helping <future teachers> plan • Observations • Instructing, modeling, coaching, etc. • Giving oral feedback and fostering reflection • Assessment. Each of the major responsibilities also contained two to four specific responsibilities. Respondents were asked to rate the likelihood of having to assume the responsibilities (response options ranged from "definitely yes" to "definitely not").
		10	Who determined the structure and nature of the activities undertaken in the school during extended teaching practice.
		11	The frequency with which field experience supervisors provided the program with written feedback on individual <future teachers>.
		12	The kinds of persons who mentor and/or assess <future teachers> during field experiences. The question asked respondents to indicate whether <future teachers> received mentoring and assessment from the following individuals during their teaching practice: • Practicing classroom teacher in school • Principal or other administrator • Inspector, <pedagogical> advisor, or other mid-level administrator • Postgraduate students in a university • Senior university teaching staff • Retired school teacher or administrator • Other personnel not included in the above categories.
		13	The type of guidance provided on how to assess extended teaching practice.
		14	The person responsible for finding extended teaching practice placements.
		15	The statement that best describes placement of <future teachers> in schools for extended teaching practice.
Part F	*Program accountability and standards*	1	The level in the institution at which decisions regarding the listed matters pertaining to the program's curriculum are made. The question listed a number of topics regarding the curriculum. For each topic, respondents were asked to identify who from institution, local district, state or provincial, or national level made the decision. The listed topics were: • Program goal and emphasis • Selection of textbooks, etc. • Standards of classroom performance • Standards of content knowledge • Subject-matter knowledge to be covered in mathematics • Mathematics <pedagogy> curriculum • General <pedagogy>/educational foundations curriculum/<liberal arts> curriculum • Number of required credits in program areas • Length of practical training • Location of practical training • Monitoring of <future teachers'> progress • Quality and frequency of supervision during practical training • Type and content of assessments • External examinations.

Exhibit 4.7: Content of institutional program questionnaire (contd.)

Part	Item Content	Item Number	Description
Part G	*Staffing*	1a)	The number of fulltime staff with teaching responsibility in the program.
		1b)	The number of parttime staff with teaching responsibility in the program.
		1c)	The distribution of the credentials held by fulltime staff members with teaching responsibilities.
		2	The academic rank held by fulltime staff members with teaching responsibilities.
		3	The academic background requirement for staff in the program who teach mathematics or mathematics-related content to <future teachers>.
		4	The academic background requirement for staff in the program who teach mathematics <pedagogy> to <future teachers>.
		5	The academic background requirement for staff in the program who supervise extended teaching practice.
Part H	*Program resources*	1	The overall annual budget of the program for the year of the study.
		2	The budget for instruction.
		3	Whether <future teachers> receive direct subsidies for living expenses.
Part I		1	Whether historical, social, or cultural factors are essential for <future teachers'> ability to understand the content of the program. If respondents answered "Yes," they were asked to provide a summary of these factors.
		2	The most distinctive strengths of the program.
		3	The main problems facing the institution.
		4	The important or unique aspects of the program that need to be made known.

Notes:

Carets (< >) denote information to be replaced with the nationally-appropriate term.

a If the answer to Question 13 was "No," the respondent skipped Question 14 and moved to Part E.

b If the institution did not offer any type of field experience, the respondent skipped the rest of the questions in this part and moved to Part F.

c If the institution did not offer short field experiences, the respondent skipped Question 3.

d If the institution did not offer extended teaching practice, the respondent skipped Questions 4 to 15 and moved to Part F.

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CHAPTER 5:

TRANSLATION AND TRANSLATION VERIFICATION OF THE TEDS-M RESEARCH INSTRUMENTS

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5.1 Overview

The international version of the TEDS-M research instruments was developed and prepared in English, the working language of IEA, by the TEDS-M international study centers (ISCs) at Michigan State University (MSU) and at the Australian Council for Educational Research (ACER), with contributions from the national research coordinators (NRCs) of the 17 participating education systems (hereafter referred to as countries). The national centers subsequently translated the instruments into local languages, 12 in total.

When preparing these national versions, each center was expected to follow specific procedures for translating and adapting the instruments to national contexts. These procedures were designed to ensure the highest quality of translation possible and appropriate cultural adaptations, while maintaining international comparability. The document providing these guidelines, *TEDS-M 2008 Survey Operations Procedures, Unit 3: Translation/Verification* (IEA, 2007a), was prepared by the ISCs and further elaborated and discussed at relevant NRC meetings during the course of the study.

A rigorous process of *verifying* the translated/adapted instruments was necessary to ensure the accuracy of the translation and equivalency of the national materials with the international version. This externally-based process was managed by the IEA secretariat in Amsterdam, the Netherlands, in association with cApStAn Linguistic Quality Control (Brussels, Belgium). After language verification, instruments were returned to the NRCs along with detailed feedback that included suggestions for changes and improvement. Once necessary changes to the text had been implemented, the ISCs further reviewed and noted any discrepancies between the layout of the national instruments and the international version. These needed to be removed before the ISC teams could give final approval to the printing and administering of the materials.

All TEDS-M participants complied well with the requirements for external verification of the survey instruments. For the majority of them, translation/layout verification occurred twice—once before the field trial and once before the main data collection, thereby assuring the highest quality of each national version.

5.2 Translating the TEDS-M Instruments

5.2.1 Survey Languages

As already noted, the TEDS-M instruments were administered in 12 different languages (see Exhibit 5.1), with English the most common language used (six countries). The majority of the participating countries used only one language for administering the survey. Four participants (Canada, Norway, Oman, and Switzerland) used instruments in two languages. The translation/adaptation process for these countries required careful checking to ensure the equivalency of the different national-language versions.

Exhibit 5.1: Languages used for TEDS-M instruments

Educational System	Language	Instruments			
		Institutional program questionnaire	*Educator questionnaire*	*Future teacher booklets—primary*	*Future teacher booklets—secondary*
Botswana	English	•	•	•	•
Canada	English French	• •	• •	• •	• •
Chile	Spanish	•	•	•	•
Chinese Taipei	Traditional Chinese	•	•	•	•
Georgia	Georgian	•	•	•	•
Germany	German	•	•	•	•
Malaysia	English	•	•	•	•
Norway [a]	Bokmål Nynorsk	•	•	• •	• •
Oman [b]	Arabic English	•	• •		•
Philippines	English	•	•	•	•
Poland	Polish	•	•	•	•
Russian Federation	Russian	•	•	•	•
Singapore	English	•	•	•	•
Spain [c]	Spanish (Castilian)	•	•	•	
Switzerland [d]	French German	• •	• •	• •	 •
Thailand	Thai	•	•	•	•
United States	English	•	•	•	•

Notes:

a Norway incorporated both Bokmål and Nynorsk into the same booklets for future teachers (part of the booklet in one language and part in the other). This procedure is used in Norwegian education.

b Oman did not include future teachers of primary mathematics in the survey. English was used as an alternative to Arabic for the educator questionnaire administered to educators from abroad who did not speak Arabic.

c Spain did not include future teachers of secondary mathematics in the survey. Although instruments were administered in Spanish (Castilian), respondents were permitted to answer in any of the official languages of Spain.

d Switzerland did not administer in French the booklets for future teachers of secondary school mathematics.

5.2.2 Instruments Requiring Translation

These included the following:

- The survey instruments for future mathematics teachers, which also included an assessment of mathematics knowledge for teaching in primary schools and secondary schools;
- The questionnaire for mathematics, mathematics pedagogy, and general pedagogy teacher educators; and
- The questionnaire for relevant personnel in the participating teacher preparation institutions.

Those countries administering the surveys in English were expected to adapt the English of the international versions to the variant of English appropriate for their context (in addition to implementing any other necessary cultural adaptations).

Because some questions and items appeared in more than one instrument, the ISCs required translation of these common elements to be identical across instruments. The ISC teams also anticipated a large number of adaptations would be needed because of specific national (cultural as well as institutional) contexts.

5.2.3 Translators and Reviewers

Each TEDS-M national center was advised to appoint a team of at least two persons—a translator and a reviewer—to carry out translation and adaptation of the instruments. Translators were expected to have an excellent knowledge of both English and the target language, and preferably experience with the educational context of the study and familiarity with survey development in general.

Reviewers, who were also expected to have an excellent knowledge of both English and the target language, were required to have experience with the study subject matters (teacher education and mathematics). These individuals were responsible for checking the translation's readability, quality, and appropriateness for the target populations and contexts. After the reviewers had completed their work, NRCs were required to incorporate the reviewers' suggestions into the translations, but they had the discretion not to implement a change they considered unnecessary or inappropriate.

If more than one translator or reviewer worked on a national version of the instruments, the ISC required the country in question to have the translation/adaptation further scrutinized in order to ensure its consistency within and across the instruments. Similarly, if a country administered an instrument in more than one language, further inspection of the cross-language consistency of the translation and adaptations was required. In these instances, NRCs were advised to engage a special reviewer—a person familiar with both languages—to check the instruments' comparability.

5.2.4 Translation and Adaptation Guidelines

The survey-instrument translation and adaptation guidelines provided in the *TEDS-M Survey Operations Procedures* (IEA, 2007b) and distributed to all NRCs (see Chapter 7 of this current report) were designed to accomplish three purposes: ensure that the translation followed the rules of the target language and country context; ensure that the translation was as close to the meaning of the international source version as possible; and enable the introduction of national adaptations where necessary.

In general, translators were asked to pay particular attention to the following aspects of their work:

- Finding words and phrases in the target language that were equivalent to those in the international version;
- Making sure that the essential meaning of the text had not changed;
- Making sure that the translated instruments asked the same questions as the international version;
- Verifying that national adaptations were equivalent and appropriate in terms of meaning, context, and cultural appropriateness; and
- Remaining aware of possible changes to the instrument layout due to translation.

The major guidelines for assessing the quality of the translation specified attention to the following matters:

- Translations should have the same register (language level, degree of formality) as the source text;
- Translated text should employ correct grammar and usage (e.g., subject/verb agreement, use of prepositions, verb tenses);
- Translated text should not clarify, omit, or add information;
- Translated text should employ equivalent qualifiers and modifiers, in the order appropriate for the target language;
- Idiomatic expressions should be translated appropriately, not necessarily word for word; and
- Spelling, punctuation, and capitalization in the target text should be appropriate for the target language and cultural context of the country.

These guidelines also applied to any adjustments made in order to adapt the international version to a national context. The design of the TEDS-M international research instruments reflected the need for inclusion of various national adaptations, such as the national definitions/terms for future teachers, programs, courses, and the like. NRCs used the ISCED system (UNESCO, 1999) to help them determine, where necessary, definitions of educational level appropriate to the respective national contexts. Information to be replaced with the nationally-appropriate term on a mandatory basis was presented in carets (< >). Optional adaptations (such as names of people) appeared in cornered brackets ([ ]).

National centers could omit questions or options that they considered did not apply to their country. They could also add national questions and additional categories if necessary. Additional questions had to be placed *after* all international questions, and changes had to be thoroughly documented. Centers were also required to provide recoding instructions if they added categories. NRCs were cautioned against making unnecessary changes when preparing the national version of the instruments, given that changes increased the likelihood of errors, which could, in turn lead to loss of data in the international database.

5.2.5 Documenting National Adaptations

The ISC asked the NRCs to document all national adaptations to the international instruments on a *national adaptation form* (NAF), one for each instrument. The NAFs were supplied as electronic documents, and each was accompanied by detailed instructions on how to complete the form at each stage of the preparation process. The forms for each survey instrument comprised three sections:

- Questions requiring national adaptations;
- Other questions featuring adaptations; and
- Questions or question parts that would not be administered.

In addition, the NAFs for the future teacher knowledge booklets included a section requiring documentation of any adaptations made to question items.

The NAFs were completed and reviewed at various stages of the instrument preparation process. Version I was completed during the internal translation/adaptation and review process and was then sent, along with the translated/adapted instruments, for translation verification. Once verification had been completed, the NRCs updated the forms to reflect any changes resulting from the verification and sent Version II of the

NAFs, together with feedback on the translation verification, to the ISCs. They also sent the instruments for layout verification.

Version III of the NAFs, containing the results of the layout verification and final documentation by the NRCs, was then prepared and submitted, along with the final versions of the questionnaires and booklets, to the IEA Data Processing and Research Center in Hamburg, which accepted them as the final documentation of national adaptations. Those countries administering the survey instruments in more than one language had to complete and submit a separate set of forms for each language. A list of adaptations made by study participants appears in the user guide for the TEDS-M database (Brese & Tatto, 2012).

5.2.6 International Translation/Adaptation and Layout Verifications

Once the survey instruments had been translated, adapted, and reviewed at the national level, the NRCs sent them and the NAFs to the IEA secretariat for language verification. This process was carried out by an independent language specialist selected in cooperation with cApStAn Linguistic Quality Control, a company which provides translation-verification services for IEA studies. Of the 17 TEDS-M countries, 13 submitted materials for verification in two rounds, once before the field trial and once before the main data collection. Verification for the remaining four countries (Canada, Malaysia, the Russian Federation, and the United States) was conducted once—prior to the main data collection. The TEDS-M ISC at Michigan State University was responsible for carrying out external verification of the *layout* of the instruments, the last step in the quality assurance of these materials.

5.2.6.1 International translation verifiers

The international translation verifiers for TEDS-M were required to have the target language as their first language, to have formal credentials as translators working in English, to be educated at university level, and—if possible—to have some experience with research in general and with research in the field of education in particular. They were also expected to have lived and worked in the country for which the verification was carried out (or to be in close contact with this country).

5.2.6.2 The translation verification process

The translation verifiers received thorough training in the work that TEDS-M required of them. This preparation included provision of general information about the study and the design of the instruments, together with a description of the translation procedures that the national centers used. The verifiers also received detailed instructions for reviewing the instruments and registering deviations from the international versions.

The primary task of the verifiers was to evaluate the accuracy of the translations and the adequacy of the national adaptations (as reported in the NAFs). The instructions given to verifiers emphasized the importance of maintaining the meaning and complexity level of the questions included in each of the instruments. Specifically, verifiers had to ensure the following:

- The translation had not affected the meaning or difficulty level of the text;
- The questions and items had not been made simpler or more complex;
- No information had been omitted from or added to the translated text; and
- All adaptations implemented in the national test instruments were written down in the NAF.

The verifiers documented any errors or suggested changes directly on the submitted instruments by using the editing functions of MS Word ("Track Changes" and "Insert Comments") and eXPert PDF, or by completing separate *translation verification report forms* if necessary. Verifiers were asked to provide, when appropriate, suggestions that would improve the comparability of the instruments and to evaluate the overall quality, accuracy, and cultural relevance of the translations.

To help NRCs understand the comparability of a translated text with the international version, verifiers were asked to assign a "severity code" to any deviations. These codes ranged from 1 (*major change or error*) to 4 (*acceptable change*) as follows:

- 1—MAJOR CHANGE OR ERROR: Examples included incorrect order of choices; mistranslation of items; omission of question or response options; incorrect translation, resulting in the answer being suggested by the question; incorrect translation that changed the meaning or level of complexity of the question; and incorrect order of questions.
- 2—MINOR CHANGE OR ERROR: Examples included spelling errors that did not affect comprehension; misalignment of margins or tabs; inappropriate changes in font or font sizes; and discrepancies in the headers and footers of the document.
- 3—SUGGESTION FOR ALTERNATIVE: These deviations usually encompassed translations that were more or less adequate, but for which the verifier suggested different wordings.
- 4—ACCEPTABLE CHANGE: The change was acceptable and appropriate but was not documented on the applicable NAF.

5.2.6.3 International layout verification

The layout verification process required ISC personnel to carry out a careful review of each page, block, and question in each instrument to ensure its comparability with the international version. NRCs were responsible for recording any adaptations that affected the layout of the instruments.

In order to facilitate layout verification, participating countries were expected to submit fully assembled instruments in PDF format. Once received by the ISC, each instrument was printed out and a "side by side" comparison, including a careful check of all figures and graphs, was done to determine the layout's visual accuracy.

In general, the layout verifiers had to ensure the following:

- Correct word emphasis and appropriate use of bolding, italics, underlining, font size, and type;
- All blocks, items, and item options present, properly spaced, and in the correct order;
- Visual clarity and identicalness of figures and graphs; and
- Accuracy of pagination, footers, and other page identifiers.

Reviewers at the ISC also evaluated all discrepancies documented in the NAFs submitted by the NRCs to determine if each was an appropriate national adaptation or an actual discrepancy. During this process, the ISC reviewers recorded all discrepancies that were not noted in the NAFs. The ISC then asked NRCs to address all reviewer comments, after which it arranged for the review process to be completed. Once all corrections and comments had been addressed and/or accepted, the ISC notified the national centers that the layout verification was complete and that they could proceed with assembling, printing, and administering the instruments.

5.2.6.4 Results of the translation, adaptation, and layout verifications

In order to assess the overall quality of the translations and adaptations of the instruments, the verifiers used a rating scale ranging from very high ("excellent" and "fluent"), through "good," to "requiring further improvement." Typical errors/issues included, amongst others, the following:

- *Translation:* Mistranslations, inaccurate translations, "word for word" translations or overly "free" translations, inconsistencies, inclusion of English words despite there being a legitimate translation for these words;
- *National adaptations:* Improper terminology, inconsistencies, undocumented adaptations, unjustified extensive adaptations;
- *Punctuation and capitalization:* Improper usage in terms of the conventions of the target language;
- *Grammar:* Use of English sentence structure inappropriate for target language
- *Spelling:* US spellings in other versions of English;
- Missing words and typos.

On receiving feedback from the translation/adaptation verification, each NRC reviewed the verifier's suggestions and revised the instruments accordingly. The NRCs accepted all or almost all suggestions made by the verifiers. The major points of disagreement concerned adapted terminology used in higher education settings, proposed synonyms, language register, and use of foreign (English) terms. Rejected suggestions were documented on a form titled the *translation verification summary form* in case any unusual results in the data analysis could be partially or fully explained by errors in the translation or adaptation of the survey instruments.

During the translation, adaptation, and layout verifications of the international instruments, the verifiers detected many errata and made these known to the NRCs. The layout verifiers also ensured, as a final check, that these errors were corrected in the national instruments.

Most countries completed verification in a timely manner. Only Malaysia submitted instruments for verification after the survey administration. However, the layout verifiers identified no problems that had the potential to affect the data analysis for that country.

5.2.6.5 NRC commentary on the verification processes

Part C of the TEDS-M survey activities questionnaire (SAQ)[1] asked the NRCs to reflect and comment on their experiences during the process of translating and adapting the TEDS-M research instruments and subjecting them to external verification. Except for the Russian Federation, all participating countries completed this section of the SAQ.

In all countries, a team of two or more persons (translator and reviewer) prepared the national version of the survey instruments and documented national adaptations, as advised by the ISCs. In the majority of cases, these individuals had a stronger

1 The main purpose of the SAQ was to enable documentation of the quality of the data-collection procedures during the various TEDS-M surveys (see Chapter 7 of this report).

background in the study subject matter—teacher education and mathematics—than in linguistics. Seven countries reported some difficulties with adapting and/or translating the instruments and scoring guides. In such cases, additional experts were consulted.

All respondents found the external translation/adaptation and layout verification of their instruments helpful for quality improvement.

5.3 International Quality Control Monitor Review

The IEA secretariat hired international quality control monitors (IQCMs) from each participating country to document the quality of the TEDS-M survey administration.[2] A significant part of the IQCMs' responsibilities involved carefully reviewing the survey instruments. The IQCMs scrutinized the final (printed) versions of the questionnaires and booklets against the international translation verifiers' comments to check whether the verifiers' suggestions had been implemented appropriately in the instruments.

The IQCMs also documented any remaining discrepancies in the instruments. These generally referenced the rare occasions when an NRC did not agree with or rephrased a verifier's suggestions. IQCMs also reported printing errors and layout inconsistencies.

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2 Chapter 8 of this report provides more information on the TEDS-M international quality control program.

CHAPTER 6:

SAMPLING DESIGN

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6.1 Overview

This chapter covers the sample designs prepared for the TEDS-M surveys. It describes the target populations, sampling strategies, and sample sizes. Only the international standard is presented in this chapter; Appendix C sets out and discusses the structure and characteristics of each country's set of samples. The chapter also describes implementation of the international sampling design and highlights any deviation from that design. It furthermore highlights uses of explicit and implicit stratification procedures, gives an account of coverage and exclusions, and provides sample sizes. Chapter 10 of this report covers in detail the strategies used to estimate the characteristics of these populations and their sampling error. Chapter 10 also provides summary exhibits displaying the expected and achieved sample sizes for all target populations. A more detailed description of the TEDS-M sampling design and its recommended implementation can be found in the sample preparation manuals for TEDS-M (IEA, 2006a) and in the survey operations procedures for TEDS-M (IEA, 2006b, 2007).

6.2 International Sampling Plan

TEDS-M employed a stratified multistage probability sampling design for all three TEDS-M surveys of the following groups:

- Future primary school teachers and future lower-secondary school teachers of mathematics in their last year of training;
- The educators of mathematics/mathematics pedagogy and general pedagogy of the future teachers; and
- The institutions where the future primary and secondary teachers were receiving their preparation to teach mathematics.

This design meant that the targeted individuals (future teachers and educators) were randomly selected from a list of in-scope future teachers and educators within each of the randomly selected teacher preparation (TP) institutions.

6.2.1 The Importance of Programs and Routes

Two of the TEDS-M key concepts—program and route—have particular relevance to the TEDS-M sampling plan. Although Chapter 2 provides definitions of these terms, brief reiteration of the meanings behind them is useful within the context of this current chapter.

A *program* is a specific pathway that exists within an institution, requires students to undertake a set of subjects and experiences, and leads to the award of a common credential or credentials on completion. A *route* is a set of teacher education programs available in a given country. TP programs within a given route share a number of common features that distinguish them from TP programs in other routes, and they can be identified in similar ways across countries. For the purposes of TEDS-M, three kinds of routes were defined (Tatto et al., 2008):

- *Concurrent:* These consist of a single program that includes courses in the subjects future teachers will be teaching (academic studies), courses on pedagogy and education (professional studies), and practical experience in the classroom.
- *Consecutive:* These routes consist of a first phase for academic studies (leading to a degree or diploma), followed by a second phase of professional studies and practical experience (leading to a separate credential/qualification). The first and second phases are not necessarily completed in the same institution. A route can only be considered consecutive if the institution or the government authorities award a degree, diploma, or official certificate at the end of the first phase. Also, in some countries, it may be customary or required for future teachers to complete the first and second phases in different institutions.
- *Apprenticeship (field experience, practicum):* These routes consist predominantly of school-based experience, with other institutions playing only a minor, marginal, or supporting role. Only one TEDS-M country (the United States) identified an apprenticeship route, but it was not included in the TEDS-M surveys.

In addition, TEDS-M referred to sets of programs within a country that shared further common features (e.g., leading to a certain degree) as *program-types.* Exhibit 6.1 lists the identified program-types and their sizes (estimated from the sample) in the participating countries. It also gives the number of institutions in each country that were estimated to be offering these different program-types as well as the estimated number of future teachers in each type. The survey samples were drawn from these numbers.

6.2.2 Target Populations

Appendix C provides the characteristics of the three main target populations for each participating country. The information it contains came from the NRCs' completed sampling frame questionnaire (see Exhibit D.1 in Appendix D), comprehensive lists of institutions, and the data collection itself. Note, however, that not all of the institutions listed were offering teacher education directed toward both the primary and secondary levels. Note also that the number of program-types rarely equated with the total number of institutions in a country since some institutions were offering more than one program-type and more than one institution was offering a program-type.

As can be seen in Exhibit 6.2, the population sizes that the NRCs estimated before sampling and data collection (the columns headed "sampling frame") sometimes deviated considerably from those estimated from the surveyed sample—the columns headed "sample estimate (sum of weights)." These deviations reflect the fact that, for some participating countries, compiling a reliable sampling frame with proper measures of the size of the institution was a task that proved difficult to fulfill. In general, increased sampling errors tend to result when sampling is done from imperfect frames.

Exhibit 6.1: Structure of mathematics teacher preparation by participating country

Country	Level [a]	Route	Program-Type	No. of Institutions	No. of Future Teachers
Botswana	1	Concurrent	Diploma in Primary Education	4	100
	2	Concurrent	Bachelor of Secondary Education (Science), University of Botswana	1	25
	2	Concurrent	Diploma in Secondary Education, colleges of education	2	35
Chile	3	Concurrent	Generalist	36	2,018 [b]
	2	Concurrent	Generalist with further mathematics education	8	181
Chinese Taipei	1	Concurrent	Elementary teacher education	18	3,595
	2	Concurrent	Secondary mathematics teacher education	19	375
Georgia	1	Concurrent	Bachelor in Pedagogy (four years)	9	636
	1	Concurrent	Bachelor in Pedagogy (five years)	1	23
	2	Concurrent	Bachelor of Arts in Mathematics	5	99
	2	Concurrent [f]	Master of Science in Mathematics	2	17
Germany [c]	1	Consecutive	Teachers for Grades 1–4 with mathematics as teaching subject (Type 1A)	7	1,286
	1	Consecutive	Teachers for Grades 1–4 without mathematics as teaching subject (Type 1B)	4	1,430
	3	Consecutive	Teachers for Grades 1–9/10 with mathematics as teaching subject (Type 2A)	7	1,093 [b]
	1	Consecutive	Teachers for Grades 1–10 without mathematics as teaching subject (Type 2B)	7	2,433
	2	Consecutive	Teachers for Grades 5/7–9/10 with mathematics as teaching subject (Type 3)	9	1,162
	2	Consecutive	Teachers for Grades 5/7–12/13 with mathematics as teaching subject (Type 4)	12	1,200
Malaysia	1	Concurrent	Malaysian Diploma of Teaching (Mathematics)	22	558
	1	Concurrent	Bachelor of Education, primary	1	19
	1	Concurrent	Diploma of Education (Mathematics)	2	50
	2	Concurrent	Bachelor of Education (Mathematics), secondary	1	82
	2	Concurrent	Bachelor of Science in Education (Mathematics), secondary	6	521
	1	Concurrent	Bachelor of Education in Teaching of English as Second Language with minor in mathematics	1 [d]	No estimation possible due to low participation
	2	Consecutive	Post-Graduate Diploma of Education (Mathematics)	5 [d]	No eligible future teachers at the time of testing
Norway	3	Concurrent	General teacher education (ALU) without mathematics option [e]	16 [b]	1,429 [b]
	3	Concurrent	General teacher education (ALU) with mathematics option	16 [b]	433 [b]
	2	Consecutive	Teacher education program (PPU)	7	78
	2	Concurrent	Master of Science [e]	6	28
Oman	2	Concurrent	Bachelor of Education, university	1	36
	2	Consecutive	Educational diploma after Bachelor of Science	1	17
	2	Concurrent	Bachelor of Education, colleges of education	6	235
Philippines	1	Concurrent	Bachelor in Elementary Education	171	2,921
	2	Concurrent	Bachelor in Secondary Education	252	3,135

Exhibit 6.1: Structure of mathematics teacher preparation by participating country (contd.)

Country	Level [a]	Route	Program-Type	No. of Institutions	No. of Future Teachers
Poland	3	Concurrent	Bachelor of Arts in Mathematics, first cycle (fulltime teacher education programs); Years: 3	16 [b]	459 [b]
	3	Concurrent	Master of Arts in Mathematics, long cycle (fulltime teacher education programs); Years: 5	15 [b]	696 [b]
	3	Concurrent	Bachelor of Arts in Mathematics, first cycle (parttime teacher education programs); Years: 3	4 [b]	67 [b]
	3	Concurrent	Master of Arts in Mathematics, long cycle (parttime teacher education programs); Years: 5	4 [b]	91 [b]
	1	Concurrent	Bachelor of Pedagogy Integrated Teaching, first cycle (fulltime programs); Years: 3	27	1,206
	1	Concurrent	Master of Arts Integrated Teaching, long cycle (fulltime programs); Years: 5	14	864
	1	Concurrent	Bachelor of Pedagogy Integrated Teaching, first cycle (parttime programs); Years: 3	37	2,195
	1	Concurrent	Master of Arts Integrated Teaching, long cycle (parttime programs); Years: 5	10	566
Russian Federation	1	Concurrent	Primary teacher education	161	8,563
	2	Concurrent	Teacher of mathematics	116	5,915
Singapore	1	Concurrent	Diploma of Education, Primary Option A	1	53
	1	Concurrent	Diploma of Education, Primary Option C	1	119
	1	Concurrent	Bachelor of Arts in Education, primary	1	33
	1	Concurrent	Bachelor of Science in Education, primary	1	42
	1	Consecutive	Post-Graduate Diploma in Education, Primary Option A	1	75
	1	Consecutive	Post-Graduate Diploma in Education, Primary Option C	1	102
	2	Consecutive	Post-Graduate Diploma in Education, secondary (January 2007 intake)	1	111
	2	Consecutive	Post-Graduate Diploma in Education, lower secondary (January 2007 intake)	1	67
	2	Consecutive	Post-Graduate Diploma in Education, secondary (January 2007 intake)	1	153
	2	Consecutive	Post-Graduate Diploma in Education, lower secondary (July 2007 intake)	1	100
Spain (primary education only)	1	Concurrent	Teacher of primary education	72	3,845
Switzerland (German-speaking parts only)	1	Concurrent	Teachers for Grades 1–2/3 (kindergarten and Grades 1–2)	5	106
	1	Concurrent	Teachers for Grades 1–2/3 (kindergarten and Grades 1–3)	2	54
	1	Concurrent	Teachers for primary education (Grades 1–6) (kindergarten and Grades 1–6)	2	304
	1	Concurrent	Teachers for primary education (Grades 1–6)	12	745
	1	Concurrent	Teachers for primary education (Grades 3–6)	2	43
	2	Concurrent	Teachers for secondary education (Grades 7–9)	6	177
Thailand	3	Concurrent	Bachelor of Education	45	1,240 [b]
	3	Consecutive	Graduate Diploma in Teaching Profession	9	12 [b]

Exhibit 6.1: Structure of mathematics teacher preparation by participating country (contd.)

Country	Level [a]	Route	Program-Type	No. of Institutions	No. of Future Teachers
United States (public institutions only)	1	Concurrent	Primary concurrent	382	20,597
	2	Concurrent	Secondary concurrent	303	2,246
	3	Concurrent	Primary + secondary concurrent	74 [b]	3,472 [b]
	1	Consecutive	Primary consecutive	81	2,031
	2	Consecutive	Secondary consecutive	85	620
	3	Consecutive	Primary + secondary consecutive	20 [b]	172 [b]

Notes:

a 1 = primary, 2 = lower secondary, 3 = primary and lower secondary.

b Estimate from sample of future teachers who took the primary test.

c The administrative units of the 16 federal states were considered to be the institutions in the sense of the TEDS-M definition.

d Estimate from sampling frame; could not be estimated from sample data.

e Program was not considered to be part of the TEDS-M core target population. Further information is given in Appendix C.

f According to information given by the national research coordinator after the survey administration, this program-type takes a consecutive structure within one of the two institutions. Note that both programs are labeled "concurrent" in the TEDS-M international database.

Exhibit 6.2: Nationally defined target populations by participating country

Country	Institutions		Future Primary Teachers		Future Lower-Secondary Teachers		Educators
	Sampling frame [a]	*Sample estimate (sum of weights)*	*Sampling frame* [a]	*Sample estimate (sum of weights)*	*Sampling frame* [a]	*Sample estimate (sum of weights)*	*Sample estimate (sum of weights)* [b]
Botswana	7	7	91	100	56	60	44
Canada (four provinces)	30	30	Not available	728	Not available	686	282
Chile	50	40	2,378	2,018	2,511	2,242	729
Chinese Taipei	34	39	3,589	3,595	444	375	339
Georgia	10	10	697	659	113	116	64
Germany	16	16	8,145	6,242	3,789	3,383	3,944
Malaysia	34	30	3,110	627	845	603	457
Norway	45	45	1,589	1,862	1,689	2,092	Data not processed
Oman	7	7	No primary education at present		287	288	103
Philippines	417	289	4,593	2,921	3,266	3,135	2,847
Poland	92	91	5,800	6,144	1,308	1,344	1,181
Russian Federation	182	177	15,618	8,563	6,872	5,915	3,135
Singapore	1	1	433	424	462	431	91
Spain (primary education only)	72	72	7,028	3,845	Not covered		770
Switzerland (German-speaking parts only)	16	16	1,230	1,252	175	177	416
Thailand	46	46	1,354	1,364	1,354	1,368	354
United States (public institutions only)	498	408	45,482	26,272	15,160	7,098	9,500

Notes:

a After institution-level exclusions.

b Population figures for educators were not available on the sampling frames.

6.2.2.1 Teacher preparation institutions

The international target population of teacher preparation institutions was defined as the set of secondary or postsecondary schools, colleges, or universities offering structured "opportunities to learn" (i.e., a program or programs) on a regular and frequent basis to future teachers of mathematics within a teacher preparation route (Tatto et al., 2008). It was not necessary within the TEDS-M sampling framework for an institution to be teaching mathematics as a subject in order to be part of the target population. However, the institution did have to be teaching mathematics pedagogy (IEA, 2007a).

TEDS-M international study center (ISC) staff asked all TEDS-M national research coordinators (NRCs) to provide a list of all routes encompassing TP programs and to indicate which were of principal interest (i.e., a major route) and which were of marginal interest to TEDS-M. The NRCs were provided with a sampling frame questionnaire to assist them with this work (see Exhibit A.1 in Appendix A). The sampling team and each NRC then worked together to determine which routes would constitute the national desired target population for the respective country. Each country could also opt to exclude routes or institutions of very small size.

The routes that remained after this process became the national defined target population (see Exhibit 6.2). Exhibit 6.3 identifies those parts of the target population in the participating countries that were excluded from sampling. The exhibit also shows the extent to which (in percentages) the defined target population covered all identified routes in each country. Appendix D provides the instruments that were used to collect the necessary information.

6.2.2.2 Teacher educators

The target population of educators was defined as all persons with regular, repeated responsibility for teaching future teachers of mathematics one of the compulsory courses of their program at any year of the program. That target population could comprise up to three subpopulations:

- *Educators of mathematics and mathematics pedagogy:* Persons responsible for teaching one or more of the program's required courses in mathematics or mathematics pedagogy during the study's data-collection year at any stage of the institution's teacher preparation program.
- *General pedagogy educators:* Persons responsible for teaching one or more of the program's required courses in foundations or general pedagogy (other than a mathematics or mathematics pedagogy course) during the study's data-collection year at any stage of the institution's teacher preparation program.
- *Educators belonging to both Groups 1 and 2 as described above:* Persons responsible for teaching one or more of the program's required courses in mathematics and/or mathematics pedagogy and/or general pedagogy during the study's data-collection year at any stage of the institution's teacher preparation program.

6.2.2.3 Future teachers

The target population of future teachers comprised all members of a route in their last year of training enrolled in an institution offering formal opportunities to learn to teach mathematics, and explicitly intended to prepare individuals qualified to teach mathematics in any of Grades 1 to 8.

Exhibit 6.3: Nationally defined target populations: exclusions and coverage

Country	Exclusions [a]	Coverage
Botswana	None	100% in all target populations
Chile	• 2% of institutions • 2% of educators • 3.8% of future primary teachers • 3.6% of future lower-secondary teachers	100% in all target populations
Chinese Taipei	• 26.1% of institutions • < 4% of educators • 4.5% of future primary teachers • 4.7% of future lower-secondary teachers	100% in all target populations
Georgia	• 1.4% of future primary teachers • 1.7% of future lower-secondary teachers	100% in all target populations
Germany	• 6% of institutions offering primary education and 3.7% of future primary teachers • 7% of institutions offering lower-secondary education and 5.6% of future lower-secondary teachers • 22% of institutions participating in the educator survey • < 5% of educators	100% in all target populations
Malaysia	None	Due to low participation, program-type Bachelor of Education in Teaching of English as Second Language with minor in mathematics not covered (< 5% of future primary teachers)
Norway	None	100% in all target populations
Oman [b]	None	100% in all target populations
Philippines	• 7.4% of institutions • < 5% of educators • 2.1% of future primary teachers • 1.7% of future lower-secondary teachers	100% in all target populations
Poland	• 3.8% of institutions • < 5% of educators • 3.0% of future primary teachers • 0.4% of future lower-secondary teachers	• Institutions offering only consecutive programs not covered (8.5% of institutions) • Percentage of educators not covered unknown • 23.6% of future primary teachers • 29.0% of future lower-secondary teachers
Russian Federation	None	Secondary pedagogical institutions (percentage of coverage unknown)
Singapore	None	100% in all target populations
Spain (primary education only)	None	Only institutions offering education to future primary teachers covered
Switzerland (German-speaking parts only)	None	Only German-speaking parts covered
Thailand	None	100% in all target populations
United States (public institutions only)	None	Only public institutions covered[a]

Notes:

a Refer to Appendix C for reasons for exclusions and for further information.

b Oman had no future primary education teachers during the TEDS-M data-collection period.

TEDS-M distinguished between two different groups of future teachers: those who would be certified to teach primary school students, and those who would be certified to teach lower-secondary school students. These two groups were referred to as belonging to two distinct "levels" of education systems (i.e., primary and lower secondary). However, in some countries, this distinction was not feasible within a program. For example, such a program may have been preparing teachers for both levels because of the expectation that these teachers would be able to teach any level (specifically, from Grades 1 to 8) in the schools where they would eventually work.

6.2.3 Sample Size Requirements and Implementation

To allow for reliable estimation and modelling, while allowing for some amount of nonresponse, TEDS-M set the minimum sample sizes within each country as follows:

- Fifty institutions per route and level;
- Thirty mathematics and mathematics pedagogy educators per selected institution (or per route/per level, if possible);
- Thirty educators of general pedagogy per selected institution; and
- An effective sample size[1] of 400 future teachers per route and level.

Implementation of TEDS-M's two-stage sample design, a design that is typically less precise than a simple random sample due to the clustering effect, meant that the future teacher sample size required for each route and level was larger than the nominal 400. The actual number of future teachers required for each route and level within the selected TP institutions and overall was therefore dictated mainly by the following:

- The total number of institutions in the country;
- The various sizes of the institutions in the country; and
- The sample selection method (e.g., simple random, cluster random) used in the institutions.

The teacher preparation institutions offering education to both future primary and lower-secondary teachers of mathematics could be part of both institution samples. Similarly, teacher preparation institutions offering more than one route to students could be part of more than one sample.

Among the 17 countries participating in TEDS-M, 12 identified fewer than 50 (or only slightly more than 50) eligible institutions. Therefore, in these countries, the sample design could no longer be described as a two-stage cluster design. Rather, it had become a stratified simple random sample, which is usually more efficient than a nonstratified simple random sample because of the high precision of the estimates for such samples.

For operational purposes, each institution in the sample was divided into subgroups defined by the level × route × program-type combinations. These subgroups, called "teacher preparation units" or TPUs (see IEA, 2007), comprised the actual programs offered in a given institution. All programs within selected institutions were thus automatically part of the sample.

1 "Effective sample size" means that the sample design had to be as efficient (i.e., precise) as a simple random sample of 400 future teachers from a (hypothetical) list of all eligible future teachers found in a route and level.

For example, the Philippines at the time of TEDS-M was offering only one teacher education route (concurrent) per education level (see Exhibit 6.1 above), namely the Bachelor in Elementary Education and the Bachelor in Secondary Education. Hence, teacher preparation institutions in the Philippines were offering teacher education for either the primary or secondary level (not both) and so had only one TPU, or they were offering teacher education for both the primary and secondary levels and so had two TPUs.

To give another example, Malaysian teacher preparation institutions at the time of TEDS-M were offering, among them, four different program-types for future primary teachers and three different program-types for future lower-secondary teachers (see Exhibit 6.1). Hence, in theory, there could be up to seven TPUs in one institution. However, in practice, institutions were usually offering only a few of the possible program-types, if not only one.

Every future teacher in scope for TEDS-M had to be allocated to one TPU only, and the minimum sample size of future teachers in their final year of training within institutions was set to 30 such teachers per TPU. This meant that all future teachers in TPUs with fewer than 30 such teachers or where the sampling of future teachers would have resulted in a sampling fraction of more than 50 percent were asked to complete the survey instruments. In countries where, on average, the number of teacher preparation institutions in a participating country was small or where the institutions themselves were small, all eligible future teachers were surveyed in order to reach the TEDS-M precision requirements.

6.2.4 Country-Based Variations to the International Sampling Strategies

Participating countries could suggest variations to or adaptations of the international sampling plan to better suit their national needs. All changes to the international sampling plan had to be reviewed and approved by the sampling team and the relevant ISC. One important modification was a reduction in the scope of the national implementation. Countries could choose to reduce their national desired target populations if political, organizational, or operational reasons made it extremely difficult for them to obtain complete national coverage. For some countries, reduced coverage meant that the survey results could not be deemed representative of their entire national teacher education systems. The international reports on the study accordingly used annotations to highlight those countries with reduced coverage of the national desired target population.

The national desired target population could be further reduced to avoid surveying very small institutions or programs of marginal importance. The TEDS-M sampling team specified that these exclusions should not amount to more than five percent of the national desired target population. Appendix C provides the reasons for exclusions in each participating country. It was the remaining population, that is, that one that would be surveyed, that TEDS-M referred to as the national-defined target population. Exhibit 6.3 above provides a summary of the population exclusions in each participating country.

6.2.5 Sampling Frames

Participating countries were asked to provide the sampling team with a current and complete list of institutions, organized by route, level, and any classification variable deemed relevant to national interests. The lists provided had to correspond with and grant access to the national-defined target populations.

6.2.6 Stratification

The international sampling plan did not require stratification (i.e., forming smaller units or strata) of the institutions, the educators, or the future teachers. Participating countries that chose to implement some form of stratification in order to answer national requirements were invited to discuss their strategy with the international sampling team. In addition, the sampling team could advise countries to use particular forms of stratification where reasonable.

Stratification could be implicit or explicit. Implicit stratification consists of ordering the sampling frame before sampling according to the specified stratification categories in order to ensure an approximately proportional allocation of the entire sample. Explicit stratification involves separating the population into strata and then drawing a separate sample from each one. Appendix C includes information on how stratification was implemented in each participating country.

6.3 Sample Selection

Because TEDS-M targeted four different populations (institutions, educators, future primary teachers, and future lower-secondary teachers), four different sampling plans were designed and implemented. Exhibit 6.4 sets out the sampling units and stages for these populations.

6.3.1 Sampling of Institutions

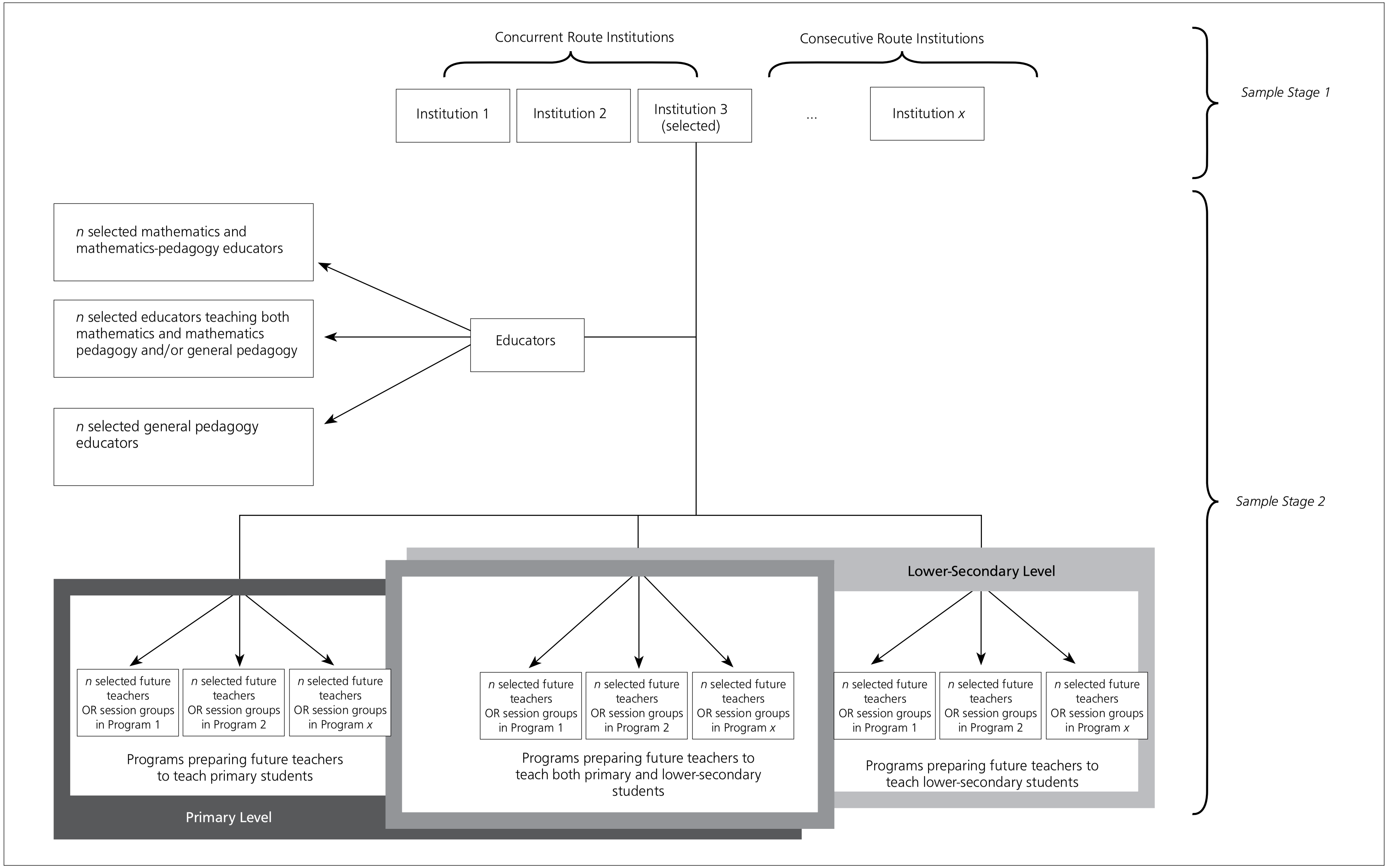
The institutions were selected on the basis of systematic random sampling within explicit strata, according to the national sampling plans. If reliable measures of size for the institutions were available, institutions were sampled with probability proportional to size (PPS). If these measures were not available, or if the institutions were so small that censuses of all targeted individuals within them were expected, institutions were sampled with equal probabilities. If implicit stratification was used, institutions were sorted by implicit stratum and a measure of size prior to sampling. Whenever possible, two replacement units were designated for each unit selected for the sample of the main survey; this was applicable solely for the sample of institutions. Nonresponding educators or future teachers could not be replaced. The sampling of institutions also comprised the first stage of sampling for the educator and future teacher populations.

6.3.2 Sampling from within Institutions

6.3.2.1 Educators

A comprehensive list of eligible educators within each selected institution was compiled. Each educator had to be allocated to one of the educator-groups described in Section 0 of WinW3S (Within-institution Sampling Software for Windows). This program, provided by the IEA Data Processing and Research Center, was used to select a systematic random sample of at least 30 mathematics/mathematics-pedagogy educators and a systematic random sample of 30 general-pedagogy educators. In all participating countries, a census of educators was conducted in the institutions where fewer than 30 educators were found in a given group.

Exhibit 6.4: Sampling stages and units



Note: For operational purposes programs were called *teacher preparation units* (refer to Section 7.4) during survey implementation.

6.3.2.2 Future teachers

Two different procedures, again using WinW3S, were used to select the future teachers within the TPUs:

1. *Selection of whole-session groups:* Some of the TEDS-M participating countries (e.g., Chinese Taipei, Germany, and the Russian Federation) and some of the selected institutions grouped future teachers together for organizational purposes. TEDS-M termed such groups "session groups." The international sampling team found it was sometimes operationally desirable and more convenient, especially in very large institutions, to select whole-session groups instead of individual future teachers.

   The downside of this sampling approach is that the sampling design tends to be less efficient because of clustering effects. This possibility was countered by appraising each situation and, where deemed necessary, increasing the within-institution sample sizes. Whenever the team chose this approach, it compiled a comprehensive list of session groups. Once each eligible future teacher in a TPU had been allocated to one, and only one, session group, predetermined numbers of session groups were randomly selected with equal probability. All future teachers within the selected session groups were asked to participate in the survey.

2. *Selection of individual future teachers:* The sampling team compiled a comprehensive list of eligible future teachers within each TPU and then either randomly selected at least 30 future teachers from it or specified that all teachers would be surveyed if there were fewer than 30 teachers within the TPU. Future teachers being prepared to teach both primary and lower-secondary levels were randomly split into two groups, each comprising half of the future teachers. The members of one half were asked to answer the primary-level survey, and the members of the other half were asked to answer the lower-secondary survey.

All sampling procedures and processes were extensively documented either by the sampling team (institution samples) or automatically by WinW3S so that every selection step remained reproducible at any time.

6.4 Sampling for the Field Trial

The field trial conducted before the main data collection took place between January and April 2007 in Botswana, Chile, Chinese Taipei, Georgia, Germany, Oman, the Philippines, Poland, Singapore, Spain, Switzerland, and Thailand. The other countries that participated in TEDS-M joined the study too late to participate in the field trial.

The sampling procedure for the field trial involved drawing convenience samples. Because of overlap in the drawing of the field trial and main survey samples in almost all the field-trial countries, convenience selection gave countries the ability to purposively select institutions that would be willing to participate in both parts of the survey. In almost every country, the respective NRC selected a convenience sample of five institutions for each level and route.

The field trial brought to light one particular challenge—obtaining high participation rates. During the trial, many NRCs reported difficulty not only with picking a convenience sample of institutions but also with ensuring that targeted respondents completed the surveys. This experience led to the development of strategies designed to enhance the willingness of all targeted populations to participate in the main survey (see Appendix E). These strategies proved to be effective. For example, nine of the 10 countries participating in the field trial saw increases in the number of selected future primary teachers completing the main survey (see Exhibit 6.5).

Exhibit 6.5: Response rates within participating institutions: field trial and main survey

Countries	Response Rate Future Primary Teachers (Percentage over all Participating Institutions)		Increase (%)
	Field trial	*Main survey*	
Botswana	95	86	-9
Chile	66	79	13
Chinese Taipei	46	90	44
Georgia	55	77	22
Germany	77	82	5
Philippines	87	91	4
Poland	63	79	16
Singapore	No calculation possible	90	n. a.
Spain	32	87	55
Switzerland (German-speaking parts only)	41	76	35
Thailand	91	99	8

Note: n.a. = not applicable.

References

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CHAPTER 7:

SURVEY OPERATIONS PROCEDURES

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7.1 Overview

The TEDS-M survey operations procedures were developed by using, as a starting point, procedures successfully applied in IEA's Trends in International Mathematics and Science Study (TIMSS) 2003 and Progress in International Reading Literacy Study (PIRLS) 2006, as well as other IEA studies. However, due to the nature of the TEDS-M target population and the aims of the study, the TEDS-M survey operations differed considerably from those employed in student-level studies conducted at primary or secondary school level. Most importantly, TEDS-M targeted adult populations—future teachers in their final year of preparation and educators teaching in teacher preparation programs of the institutions sampled for the study.

The TEDS-M data collection, carried out locally within the participating countries, followed standards, guidelines, and detailed procedures for all survey activities provided by the international TEDS-M team. Because the organization of teacher preparation varied substantially across participating countries, the TEDS-M researchers found it challenging to develop standardized operational procedures that would ensure the collection of internationally comparable data and could be readily implemented in all participating countries. For instance, enumerating the targeted individuals and securing their participation proved to be much more difficult than in a student-level survey. Administering questionnaires to teacher preparation institutions, teacher educators, and future teachers in vastly varying numbers of institutions per country (ranging from 5 to 200 institutions) was a demanding exercise. Conducting a successful data collection called for close cooperation between and among the international study centers and associated experts, the national research coordinators (NRCs), the within-institution liaison people (termed "institution coordinators") and, eventually, the questionnaire respondents.

This chapter describes the survey operations for the entire data-collection process. It outlines the responsibilities of the NRCs, the procedures for listing, sampling, and tracking future teachers and educators, the steps involved in administering the questionnaires in a uniform way, and the preparation of materials for data capture.

7.2 Field Trial

All procedures were field trialed in the majority of the participating TEDS-M countries. The aim of the field trial, conducted in early 2007, was to validate the survey instruments, operational software, and the various procedures associated with the study. For this purpose, the TEDS-M sampling team selected a convenience sample of 10 institutions in most countries.

On the basis of the field trial experience and results, the TEDS international teams refined and improved the instruments, procedures, and software where needed. NRCs also provided valuable feedback during this stage. Strategies and best practices for achieving high response rates were presented and discussed during plenary sessions of the third meeting of the NRCs as well as bilaterally between NRCs facing similar obstacles, such as securing permission from regional authorities to conduct the survey.

7.3 NRC Responsibilities

In each country, a research center under the direction of the NRC was responsible for implementing TEDS-M. The NRC was the key contact person for and between all individuals, institutions, and authorities involved in TEDS-M within the country. The NRC also represented his or her country at the international level and was responsible for any national decisions regarding the study in consultation with the TEDS-M international study centers and experts. In most countries, the NRC appointed a person to take responsibility for all data-related tasks and issues. This person, called the national data manager (NDM), supervised and trained data-entry staff and became, after the TEDS-M survey data had been sent to the IEA DPC, the main contact person during data processing and cleaning.

7.4 Manuals and Software

A series of survey operation procedure manuals provided the national centers with instructions, guidelines, and advice on implementing TEDS-M within participating countries. The manuals were integral to ensuring the quality of the study's implementation and the international comparability of its data and results.

The manual series, titled *Survey Operation Procedures*, constituted nine units accommodating the different stages of the survey. Each was accompanied, where necessary, by additional materials or software, as listed below.

- Unit 1, Parts 1, 2, and 3: Conducting the TEDS-M 2008 field test (IEA, 2006a).
- Unit 2: Contacting institutions (IEA, 2007a), accompanied by sample letters.
- Unit 3: Translation, international translation verification, and international layout verification (IEA, 2007b).
- Unit 4: Instrument production, assembly, and layout (IEA, 2007c).
- Unit 5: Within-institution listing and sampling (IEA, 2007d), accompanied by:
  - WinW3S (Within-institution Sampling Software for Windows), used to accomplish the following: track sampled institutions; prepare survey tracking and listing forms for future teachers and educators; enumerate session groups, educators, and future teachers, and randomly select them; track these individuals' participation status; assign questionnaires to future teachers; print labels for the questionnaires; and administer the questionnaires.
- Unit 6: Administering the survey (IEA, 2007e), accompanied by:
  - Institution coordinator manual (IEA, 2007f), describing the role, responsibilities, and tasks of the institution coordinator as a main contact person within each participating institution;
  - Survey administrator manual (IEA, 2007g), describing the role, responsibilities, and tasks of the survey administrator, including the distribution of the future

teacher instruments, supervising the sessions, ensuring the correct timing of the sessions, and recording future teacher participation;
  - National (IEA, 2006b) and international (IEA, 2007h) quality control monitor manuals, providing the quality control monitors (QCMs) with information about TEDS-M and describing their role and responsibilities in the project. The manuals specified the timelines, actions, and procedures that needed to be followed in order to carry out the international and national quality-assurance programs.
- Unit 7: Scoring constructed-response items (IEA, 2007i), accompanied by:
  - Scoring guides for the constructed-response items (IEA, 2007j), providing detailed, explicit guidance on how to score each item.
- Unit 8: Syllabi analysis coding (IEA, 2007k).
- Unit 9: Creating the data files (IEA, 2007l), accompanied by:
  - Windows Data Entry Manager software (WinDEM) for entering, editing, and verifying the TEDS-M data;
  - Codebooks, describing the properties and the layout of the variables to be entered from each TEDS-M instrument.

7.5 Procedures for Contacting Institutions and for Within-Institution Sampling

The necessary and, in many cases, critical first step during the TEDS-M survey field activities was to establish good working relationships with the institutions that had been sampled to participate in the study.[1] NRCs were responsible for contacting these institutions and encouraging them to participate. In some countries, this process involved obtaining support from national or regional educational authorities. Appendix E provides the guidelines on mobilizing national support and recruiting institutions issued by the TEDS-M international study centers.

7.5.1 Institution Coordinators

National centers identified and trained institution coordinators for all participating institutions. These individuals could be a respected administrator or member of the teaching staff in the institution or a representative of the TEDS-M national center. These individuals needed to have attributes that would enable them to ease entry of TEDS-M personnel into the institution and facilitate cooperation between the two. The affiliation nomination of institution coordinators varied across the participating countries. However, in general, NRCs were encouraged to find a solution that maximized acceptance and participation among the staff and students in the sampled institutions and satisfied rules and regulations regarding the confidentiality and sharing of personally identifiable information.

All institution coordinators received a copy of the *TEDS-M Institution Coordinator Manual* (see above), which described their responsibilities. These included:

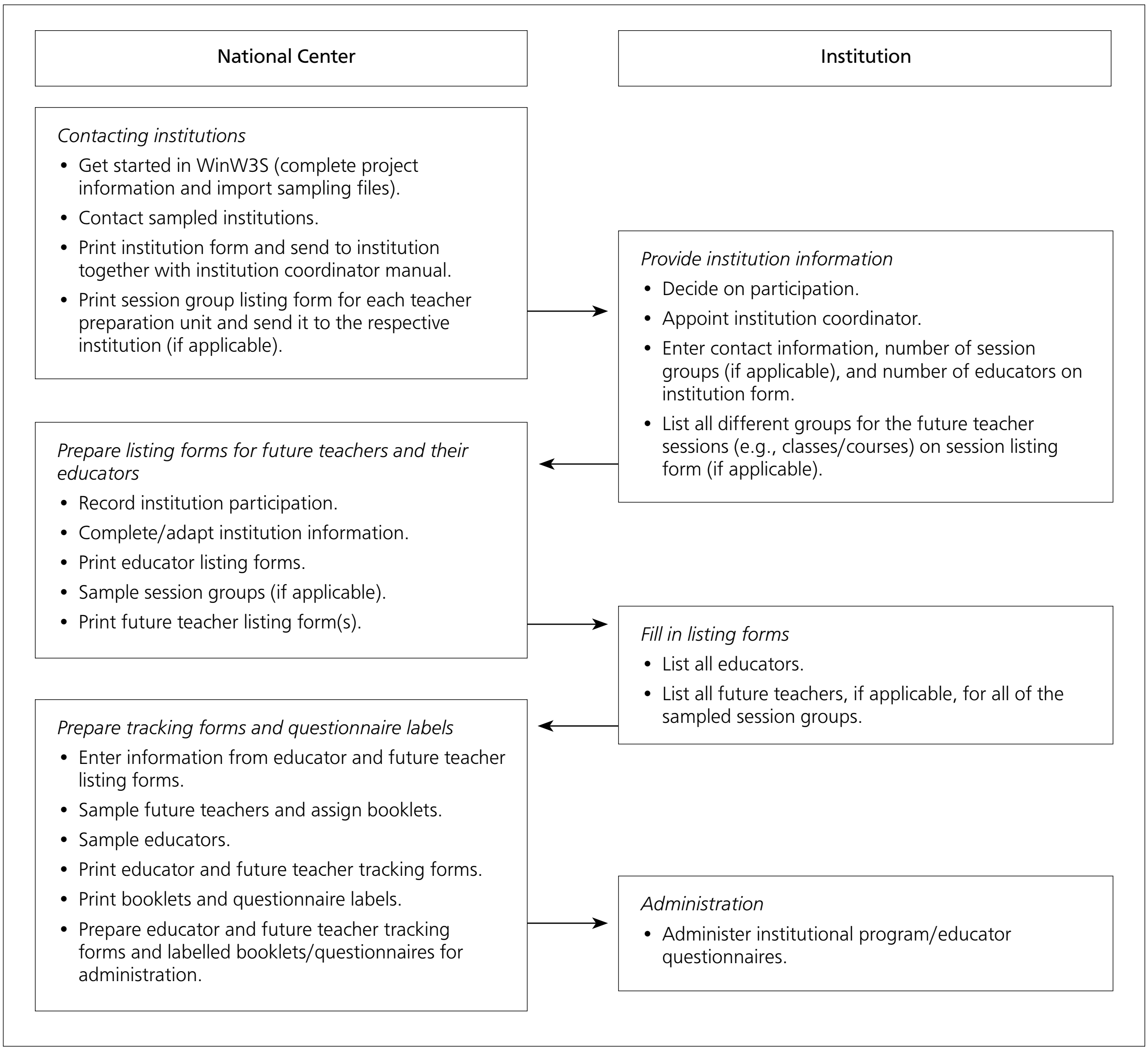
- Providing the national center with all necessary information about the sampled institution, including lists of eligible educators and future teachers;
- Coordinating the date, time, and place for future teacher survey sessions;

1 For more information on all sampling procedures, please refer to Chapter 6.

- Coordinating the distribution and collection of educator and institutional program questionnaires according to required confidentiality measures; and
- Completing the future teacher and educator tracking forms and recording the participation status of each sampled individual.

Exhibit 7.1, in addition to illustrating the workflow between the national center and the institutions, outlines the tasks and responsibilities of the institution coordinator.

Exhibit 7.1: TEDS-M preparation for survey administration



7.5.2 Survey Listing and Tracking Forms

TEDS-M relied on a series of forms to list all in-scope individuals, to prepare the sampling of session groups, educators, and future teachers, to prepare the assignment of questionnaires, and to track the participation status of sampled individuals. The forms not only facilitated the data-collection and data-verification processes but also provided information from which to compute sampling weights and allow evaluation of the quality of the sampling process. Most of the tracking and listing forms were created automatically by the WinW3S software, then completed by institutions and returned to the national centers.

TEDS-M used six tracking and listing forms, brief descriptions of which follow.

- *Institution form:* This form, created using WinW3S software, was used to gather contact information about and the number of teacher educators within each selected institution.
- *Session-group listing form:* A separate session-group listing form was created in WinW3S for each teacher preparation unit (TPU)[2] of those selected institutions in which sampling would encompass future teacher session groups (e.g., classes or courses). NRCs sent this form to the institution coordinator in each relevant institution and asked him or her to list all eligible session groups in all TPUs within it as well as the number of future teachers within each session group.
- *Educator listing form:* This form was used to list all educators of a sampled institution who were part of the target population(s). The institution coordinators listed the names of the educators (or a sequential number if data-protection laws did not allow for individual names), their date of birth, gender, the ID(s) of the TPU(s) they were teaching, and the educator-group they belonged to—that is, mathematics and/or mathematics pedagogy educators, general pedagogy educators, or educators in both aforementioned groups.
- *Educator tracking form:* This form listed all sampled educators. Institutional coordinators used this form to distribute questionnaires to educators and to indicate their participation.
- *Future teacher listing form:* This form was created for each TPU or, if applicable, a sampled session group within a sampled institution, and was then sent to the institution coordinator for completion. Institution coordinators listed the names (or a sequential number; see above), date of birth, and gender of the future teachers in the TPU or session group.
- *Future teacher tracking form:* This form was used to list all sampled future teachers and their assigned booklet rotation. The survey administrators used this form to verify the assignment of the instruments to future teachers and to indicate their participation.

7.5.2.1 Identification numbers

In order to enable TEDS-M personnel to track each institution, educator, and future teacher, the WinW3S software assigned hierarchical identification codes (IDs), as set out in Exhibit 7.2. The first three digits of the ID system identified institutions. The fourth digit for an institution was always a "0." Teacher preparation unit IDs also started with the three-digit institution identifier. A sequential number, starting with "1," was then added for the first TPU within an institution. For example, the first sampled institution for the main study was identified by "101." Accordingly, the institution ID was "1010." The first TPU of that institution was numbered "1011," the second TPU of that institution was numbered "1012," and so on. Note that this rule could not be applied in Singapore because its teacher preparation institution[3] contained 10 TPUs. Consequently, the IDs of this particular institution had to be increased by one digit (III+TT+CC+FF). As a result, the TPU IDs in Singapore consisted of five digits, the educator and session group IDs consisted of seven digits, and the future teacher IDs nine digits.

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2 Chapter 6 provides a definition of the term "teacher preparation unit."

3 Singapore had only one teacher preparation institution.

Exhibit 7.2: TEDS-M hierarchical identification system codes

Unit	ID Components	ID Structure	Numeric Example
Institution	Institution	III + "0"	1010
Educator	Institution + educator within institution	III + "0" + EE	101001
Teacher preparation unit	Institution + teacher preparation unit within institution	III + T III + T	1011 1011
Session group	Teacher preparation unit + session group within teacher preparation unit	III + T + CC	101101
Future teacher	Teacher preparation unit + session group within teacher preparation unit + future teacher within session group	III + T + CC + FF	10110101

7.5.3 Assigning and Shipping Materials to Institution Coordinators, Educators, and Future Teachers

Once materials had been printed, they were distributed to the institutions. This process required careful organization and planning by the NRCs. With the aid of labels and tracking forms produced by WinW3S, NRCs assigned each sampled future teacher one questionnaire (booklet) consisting of background and cognitive sections. The questionnaires were assembled in the format of a rotated block design so that each block of cognitive items could be assigned to approximately equal numbers of future teachers (see Chapter 3 of this report for more information on this design). Different cognitive item blocks were assigned to future primary and future lower-secondary teachers. NRCs sent the future teacher questionnaires (FTQs) to each survey administrator and asked him or her to keep this material in a secure place until the day of the survey sessions.

NRCs also assembled and parceled up all other required materials for each survey session group in the participating institutions. Each packet contained questionnaires for all educators listed on the educator tracking forms for the institution, as well as institutional program questionnaires for the people representing each participating TPU in the institution. NRCs sent these materials to each institution coordinator shortly before the survey administration period and asked him or her to confirm receipt of them.

7.6 Administering the TEDS-M Questionnaires

Administering the TEDS-M 2008 survey in each participating country was a collaborative task shared between the national research center, the institution coordinator, and the survey administrator. The institution coordinator administered the institutional program questionnaire(s) (IPQs) and distributed and collected the educator questionnaires (EQs) and any applicable information for the syllabi analysis. The IPQ, designed as a guided interview, was administered to one or more executive representatives of each TPU. The institution coordinator was also responsible for reminding educators to fill out the questionnaires by certain reference dates and to record the educators' participation on the educator tracking forms. The survey administrator handed out the EQs to the sampled educators and arranged to collect them at a later, specified stage.

7.6.1 Survey Administrators' Role

Working in collaboration with the institution coordinator, the survey administrator was responsible for organizing the survey session for future teachers. The international TEDS-M researchers strongly recommended that the survey administrator for each institution should be someone from outside it, preferably appointed and supervised by the national center. This approach was seen as one that addressed confidentiality concerns raised by survey respondents and NRCs alike. It also safeguarded the security of the cognitive sections of the FTQs.

In order to ensure that the FTQs were administered in exactly the same way in all participating countries, survey administrators needed to follow a set of precise, scripted procedures, which encompassed these responsibilities:

- Preparing and organizing the survey session in cooperation with the institution coordinator (date, time, and location);
- Receiving and securing the survey materials in sufficient time before survey administration, usually one week in advance;
- Reviewing all materials as they arrived from the national center in order to ensure that they were complete, the questionnaires properly labeled, and the FTQs sorted in a sequence corresponding to the future teacher IDs on the future teacher tracking form;
- Liaising with the institution coordinator on the scheduled survey date and time and setting up the room immediately prior to the session;
- Ensuring that each future teacher received the correct survey instrument intended for him or her;
- Administering the session using an internationally standardized script;
- Ensuring the correct timing of the survey sessions, and recording the time when the various parts started and ended, along with more general feedback about the administration;
- Accurately recording on the future teacher tracking form the participation status (present or absent) of the selected future teachers during the survey; and
- Returning all materials, including all completed and all unused questionnaires, to the national center.

7.6.2 Timing of the Future Teacher Sessions

The TEDS-M international team specified that the FTQs should be administered on the same day with no break in between sections. The national centers asked institutions if the day of the session could preferably not be the first or the last day of the institution's working week, or be a day directly before or after a holiday or examination. Centers also asked institutions if they could avoid scheduling the future teacher sessions in the early morning or late in the institution's working day so as to limit absenteeism and reduced response rates.

To ensure that future teachers completed all parts of their respective booklets, the TEDS-M international team set the timing of the FTQ sessions for the TEDS-M main study as follows:

- Approximately 5 to 10 minutes for preparation, which included the administrator assigning future teachers to seats, distributing booklets, and reading out instructions.

- Ninety minutes for completing the questionnaire as follows:
  - Part A: Background—5 minutes;
  - Part B: Opportunity to learn—15 minutes;
  - Part C: Mathematics knowledge for teaching—60 minutes;
  - Part D: Beliefs about mathematics and teaching—10 minutes.
- Approximately 5 to 10 minutes to collect and package materials and finalize the future teacher tracking form and the survey administration form.

Because a high participation rate was vital for the quality of the collected data, institutions could schedule a makeup session for those future teachers absent during the original survey session and/or if participation in the original session was too low due to unforeseen circumstances (e.g., storms and the like). The survey administrator, the institution coordinator, and the NRC jointly determined if a makeup session was likely to substantially increase the response rate. Only those future teachers who were originally selected as part of the sample and who were listed on the future teacher tracking form could take part in a makeup session.

7.6.3 Documenting Participation

During each future teacher survey session, the survey administrator recorded the participation of the future teachers on the future teacher tracking form using four different codes to record the participation/nonparticipation of these teachers:

- Code "P" if the future teacher participated in the session;
- Code "A" if the future teacher was absent from the session;
- Code "NA" if the future teacher had left the TPU permanently;
- Code "TL" if the future teacher had left the TPU temporarily (e.g., long-term sick leave, sabbatical leave, maternity leave).

7.6.4 Receipt of Material and Data-Entry Preparation

In order to maintain the integrity of all information and materials and to monitor the progress of the survey, the international team sent NRCs guidelines on how to organize and document the receipt of materials and how to store them in an orderly way prior to beginning data processing at the national centers. NRCs not only had to organize all materials in a way that would facilitate the work flow for data scoring and entry but also ensure that each participating institution returned all survey materials. If an NRC found some of the survey materials were missing, incomplete, or unusual in any way, he or she was responsible for contacting the relevant survey administrator and/or institution coordinator with the aim of rectifying the problems.

More specifically, NRCs were asked to:

- Check that all survey administration forms and survey tracking forms were returned from the institutions and completed correctly;
- Record the date on which the national center received materials from the institutions;
- Check that the FTQs received were those for the future teachers listed on the future teacher tracking forms;

- Contact the respective survey administrator and institution coordinator if FTQs were missing or otherwise irregular, and then record on the future teacher tracking form if any or all of the missing FTQs could not be found or other problems not solved;
- Verify that identification codes were written on all instruments and that each FTQ was clearly labeled with a future teacher ID;
- Check that a future teacher's participation status matched the availability of instruments; and
- Check the information provided on the educator tracking forms so as to confirm the return of all EQs.

7.6.5 Survey Activities Questionnaire

In order to document and aid review of the quality of procedures after completion of the data collection, the international team asked each NRC to provide feedback via a survey activities questionnaire (SAQ). The SAQ was used to gather feedback about the assessment materials (e.g., questionnaires, manuals, scoring guides, and software) as well as countries' experiences with regard to the survey operations procedures in general and the specific survey phases and tasks in particular. The questionnaire, designed in modules that chronologically followed TEDS-M survey activities, was administered online. A summary of the responses provided by the NRCs at this stage of TEDS-M appears in Chapter 9 of this report.

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CHAPTER 8:

QUALITY ASSURANCE OF THE TEDS-M DATA COLLECTION

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8.1 Overview

Quality assurance in large-scale international surveys is extremely important in terms of making valid comparisons across many countries. In order to ensure the quality of the TEDS-M data, considerable effort was put into developing standardized materials and controlling the procedures for each step of the study, from the preparation of the assessment framework to the final data reporting. As part of this endeavor, the IEA Secretariat developed and managed a special international quality control program designed to document the TEDS-M data-collection activities in the selected teacher education institutions of the participating countries. The outcomes of this work are the central focus of this chapter.

In cooperation with the study's national research coordinators (NRCs), the IEA Secretariat appointed an international quality control monitor (IQCM) in each participating country. The IQCMs' major task was to visit randomly selected teacher education institutions to observe the data collection from future teachers and to interview the persons responsible for coordinating and administering this activity in each institution. The IQCMs were required to record their observations and interview results on a form called the TEDS-M session observation record. They were also asked to comment on whether or not the translation verifications of the national research instruments had been implemented (see Chapter 5). In total, the IQCMs observed 87 sessions (three to eight per country, depending on the number of participating institutions and their availability). Section 8.2 of this chapter focuses on the IQCMs' work.

As a counterpart to the *international* quality control program, all TEDS-M national centers implemented a *national* quality control program, which was developed in accordance with instructions and support materials provided by the IEA Secretariat. The duties of the national quality control monitors (NQCMs) were similar to those of the IQCMs, and the NRCs summarized the various aspects of the monitors' work on the TEDS-M survey activities questionnaire (SAQ). The results of this process are covered in Section 8.3 of this chapter. The NRCs also provided other information in the SAQ on the implementation of the TEDS-M procedures in their local contexts. This information included feedback on the operational procedures associated with the quality of the assessment materials. Selected results are summarized in Section 8.4 of this chapter.

8.2 International Quality Control of the TEDS-M Survey Administration

To facilitate implementation of the international quality control program, the IEA Secretariat organized an extensive two-day training workshop for all IQCMs. This workshop included an introduction to the TEDS-M project, an overview of all major survey operations, and detailed information on the data collection. The IEA Secretariat also produced the TEDS-M international quality control monitor manual (IEA, 2007a), which was distributed to all IQCMs. It provided comprehensive instructions pertaining to the monitors' required duties. In addition, the IQCMs received the TEDS-M session observation record (IEA, 2007b), which they used to document their monitoring activities, and a package of other relevant materials that included the international version of the survey administration manuals.

The main responsibilities of each IQCM consisted of consulting with the NRCs to gather required information and documentation, observing and reporting on selected survey administration sessions, and commenting on implementation of the translation verifications of the survey instruments. More particularly, the IQCMs were required to accomplish the following:

- Gather a complete set of the final national survey instruments and manuals;
- Select, in consultation with their country's national research center and in accordance with specific guidelines, the teacher education institutions where the data-collection sessions would be observed;
- Contact the institution coordinator and survey administrator of each selected institution to organize the monitoring visit and arrange interviews with these two people;
- Observe the selected survey administration sessions for their level of adherence to the administration guidelines, in each case documenting the activities of the session on the session observation record;
- Verify the completeness and accuracy of the lists of future teachers and educators for each institution/session;
- Interview the institution coordinator and survey administrator and record their responses on the session observation record;
- Review the national research instruments and translation verification results, and document whether the verifiers' comments had been implemented; and
- Submit all collected national materials and completed observation records to the IEA Secretariat.

8.2.1 International Quality Control Monitors

TEDS-M required the IQCMs to be external to the national center, familiar with the type of institution participating in the study, and acceptable as an observer at the selected institutions. The IEA Secretariat employed the monitors on a contract basis and provided them with training, an honorarium for their work, and reimbursement of travel expenses associated with their participation in the international training workshop and visits to the institutions and national center. In a few cases, the IQCMs were permitted to recruit one or more assistants in order to effectively comply with the data-collection timetable.

8.2.1.1 Selecting institutions for observation and collecting survey materials

In preparation for their monitoring duties during the TEDS-M survey administration, the IQCMs visited their respective national center in order to select the institutions that would be included in the international quality control program and to collect the survey materials used in their country. IQCMs carried out the selection of institutions jointly with the NRCs in order to prevent the inclusion of institutions that were to take part in the national quality control program and to eliminate institutions too difficult to be reached from the IQCM's home or work because of budget constraints. At least 10 percent but no fewer than three of the institutions participating in TEDS-M in each country were selected for observation. The exception was Singapore, which had only one teacher education institution. In total, 85 observations were collected from the selected institutions. Exhibit 8.1 presents the number of participating institutions in each country and the number of IQCM observations made across these institutions.

Exhibit 8.1: Number of participating institutions and number of IQCM observations

Country	Number of Participating Institutions	Number of IQCM Observations
Botswana	7	4
Canada	6	3
Chile	51	6
Chinese Taipei	19	5
Georgia	10	5
Germany	16	5
Malaysia	29	5
Norway	22	5
Oman	7	3
Philippines	80	8
Poland	50	5
Russian Federation	50	5
Singapore[a]	1	5
Spain	50	5
Switzerland	35	5
Thailand	48	5
United States	60	6

Note: a In Singapore, only one institution participated in TEDS-M; observations focused on five different groups of students.

The IEA Secretariat asked the NRCs to prepare necessary documentation and survey materials for the IQCMs. These included the following:

- National (translated and adapted) versions of the institution coordinator manual and the survey administrator manual (IEA, 2007c, 2007d);
- The final versions of the national (printed) survey instruments together with their translation verification reports; and
- Listing forms and tracking forms of sampled future teachers and their educators in the selected institutions.

8.2.1.2 Observations of the TEDS-M survey administration

For each survey administration session observed, the IQCM was required to complete the TEDS-M session observation record. This document was organized into four sections (listed below) so as to facilitate the recording of the major activities of the survey administration and other relevant information. Future teachers were generally referred to as "students" in these materials.

- Section A: Preliminary activities of the survey administrator;
- Section B: Survey administration activities;
- Section C: Summary observations; and
- Section D: Interview with the institution coordinator and survey administrator.

8.2.1.2.1 Preliminary activities of the survey administrator

Section A of the session observation record addressed the quality of the preparation for administration of the future teachers' surveys. IQCMs were asked to record their observations of the condition of the survey materials, the survey administrator's level of preparation, and the suitability of the room in which the survey took place. Exhibit 8.2 provides a summary of the information that the IQCMs recorded on this section of the session observation record.

Exhibit 8.2: Quality of the survey administration's preliminary activities (percentage of IQCM responses)

Questions	Yes (%)	No (%)	Do Not Know/ Not Answered (%)
Did the survey administrator verify adequate supplies of the future teacher booklets prior to the students' arrival?	96.5	1.2	2.3
Did the student identification information on the survey booklets correspond with the information on the future teacher tracking form?	96.5	2.3	1.2
Did the survey administrator familiarize himself or herself with the survey administration script prior to the session?	90.6	5.9	3.5
Was there adequate seating space for the future teachers to work without distractions?	97.6	1.2	1.2
Was there adequate room for the survey administrator to move around during the session to ensure that students were following directions correctly?	87.1	11.7	1.2
Did the survey administrator have a watch with a second hand (or stopwatch or timer) for accurately timing the survey session?	91.8	5.8	2.4

In general, the IQCMs observed very few procedural deviations. The most common issue reported related to those instances when the survey was conducted in a lecture-style classroom or auditorium. These venues at times made it difficult for survey administrators to move around the room. In most cases, other problems were either of a minor nature (e.g., the need to make annotations on the future teacher tracking form because of recent changes in the class membership) or resolved swiftly (e.g., using the clock on a cellphone to time a survey session because of the absence of other timepieces) and did not jeopardize the process of survey administration.

8.2.1.2.2 Survey administration session activities

Section B of the session observation record addressed the key activities that took place during the administration of the future teacher survey booklets. The information that had to be registered in this section of the record included the time taken to prepare for a survey and the time taken to complete the survey, as well as the quality of instruction before and during the survey.

In the majority of observed cases, the survey administrators followed prescribed procedures for the activities immediately before the future teachers began work on the booklets. Generally, when changes to the survey administration script occurred (25 cases), the IQCMs did not consider them to be major issues, typically characterizing them as additions or revisions. IQCMs reported that some administrators repeated or summarized instructions for the future teachers (e.g., to accommodate latecomers); in other instances, the survey administrators added words of clarification or encouragement (especially in the case of countries where there were concerns about future teachers' motivation to participate). These additions were also reflected in the total time survey administrators spent preparing future teachers for the assessment, which took 20 minutes or longer in five cases, instead of the suggested 5 to 10 minutes (the average time was about eight minutes). Exhibit 8.3 summarizes the information that the IQCMs recorded about the pre-survey activities.

Exhibit 8.3: Quality of administration activities immediately preceding answering of future teacher booklets (percentage of IQCM responses)

Questions	Yes (%)	No (%)		Not Answered (%)
		Minor change	*Major change*	
Did the survey administrator follow the script exactly in each of the following tasks?				
• Preparing the students	81.2	15.2	1.2	2.4
• Distributing the booklets	90.5	4.7	2.4	2.4
• Giving instructions	76.5	15.3	3.5	4.7
If the survey administrator made changes to the script, how would you describe them?[a]				
• Additions	58.3	37.5	0.0	4.2
• Revisions	54.2	29.2	0.0	16.6
• Deletions	29.2	58.3	0.0	12.5
Did the survey administrator distribute booklets in a manner to make sure that each student received the booklet specifically prepared for him or her?	97.6	1.2	0.0	1.2
Did the survey administrator record attendance correctly on the future teacher tracking form?	91.8	2.4	0.0	5.8

Note: a Percentages relate to 24 observations for which minor or major changes to the administration script were noted.

One major task of the IQCMs during administration of the future teacher booklets was registering whether the time requirements for completing each of the four parts of the booklet were met. In about 15 percent of cases, the IQCMs observed inconsistencies between the total allowed and observed times for the survey administration. In general, however, these differences were minor; on average, reported times for completing each part of the booklet were within one minute of the allotted times. In one instance, due to unclear printing of some items in the test booklets, students received five additional minutes to finish part of the survey. Consistent with earlier observations, IQCMs reported that some survey administrators had difficulty moving around the room to check on participants. At the closing of nearly every observed session, future teachers complied well with the instruction to stop work, and the administrators collected and secured completed booklets as required. Exhibit 8.4 provides a summary of the observations recorded in relation to these matters.

Exhibit 8.4: Quality of administration of future teacher booklets (percentage of IQCM responses)

Questions	Yes (%)	No (%)	Not Answered (%)
Did the time for all parts equal the time allowed?	82.3	15.3	2.4
Did the survey administrator announce, "You have 5 minutes left" prior to the end of Part C?	91.8	8.2	0.0
Did the survey administrator announce, "You have 5 minutes left" prior to the end of Part D?	88.2	11.8	0.0
Were there any other "time remaining" announcements made during the session?	25.9	72.9	1.2
During the session was the survey administrator moving around the room and checking whether the future teachers were working on the correct part of the booklets?	87.1	12.9	0.0
At the end of the session, how well did the students comply with the instruction to stop work?	97.7	0.0	2.3
• Very well, all students stopped work	87.1		
• Well, almost all students stopped work	10.6		
• Fairly well, some students did not stop	0.0		
• Not well at all; many students did not stop	0.0		
Were the booklets collected and secured after the surveying session?	97.6	0.0	2.4

8.2.1.2.3 General observations

Section C of the session observation record related to the IQCMs' general impressions of the observed survey administration, including students' behavior and its monitoring by the survey administrator. Nearly all students who took part in the survey behaved, in the opinion of the IQCMs, in an orderly and cooperative fashion. In about 73 percent of cases, the participating future teachers were described as extremely orderly and cooperative, and in just over 22 percent of cases future teachers were described as moderately orderly and cooperative. There were very few reported instances of future teachers attempting to cheat or engaging in behavior (such as talking during the session) that might be construed as cheating. More commonly, IQCMs reported occasions where future teachers briefly left the room during the survey (26% of sessions) or refused to participate (usually only one or two individuals in each case, but with 10 reported in one of the sessions). Late-arriving future teachers were observed in 38 percent of all sessions. They were either not admitted (17%) or could still be admitted before the survey session began (also 17%). These findings are summarized in Exhibit 8.5.

IQCMs' general opinions of the overall quality of the survey implementation were mostly positive, ranging from "excellent" (57% of cases) to "very good" (32%) and "good" (7%); only 3.5 percent of sessions were characterized as "fair" overall. None of the sessions was considered "poor." Canada, Germany, and Norway received the highest average score from the IQCMs in their evaluations of the survey administrators' performance.

The IQCMs generally considered that the administrators addressed future teachers' questions appropriately. In a small number of cases (3 of 22), the IQCMs reported that the survey administrators did not secure the survey booklet as instructed when a future teacher left the room (typically, the booklet was left on his or her desk without further incident). These opinions and observations are summarized in Exhibit 8.6. The information presented in Exhibit 8.7 shows that there were a few cases where the booklets for future teachers were defective and needed to be replaced due to printing errors or errors in a question that had not been corrected before printing. Only in one case was replacement impossible; the future teachers' responses to this defective item were not included in the TEDS-M database.

Exhibit 8.5: Quality of future teachers' behaviors when answering the surveys (percentage of IQCM responses)

Questions	Yes (%)	No (%)	Not Answered (%)
To what extent would you describe the students as orderly and cooperative?	98.9	0.0	1.1
• Extremely orderly and cooperative	72.9		
• Moderately orderly and cooperative	22.4		
• Somewhat orderly and cooperative	2.4		
• Hardly cooperative at all	1.2		
Did you see any evidence of students attempting to cheat on the survey (e.g., by copying from a neighbor)?	5.9	92.9	1.2
Were any late students admitted to the surveying room?	21.2	76.5	2.3
• Yes, but before the surveying session began	16.5		
• Yes, after the surveying session began	4.7		
Did any students refuse to take the survey either prior to or during the surveying?	8.2	90.6	1.2
Did any students leave the room for an "emergency" during the surveying?	25.9	69.4	4.7

Exhibit 8.6: Quality of survey administrators' control over administration process (percentage of IQCM responses)

Questions	Responses (%)	Responses (%)	Responses (%)
	Yes	*No*	*Not answered*
In your opinion, did the survey administrator address students' questions appropriately? [a]	94.1	1.2	4.7
If a student left the room, did the survey administrator address the situation appropriately (collect the survey booklet, and if student readmitted, return the survey booklet)? [b]	77.3	13.6	9.1
In general, how would you describe the overall quality of the survey session?	*Excellent, very good, good*	*Fair, poor*	*Not answered*
	95.3	3.5	1.2

Notes:

a Survey administrators were instructed not to answer any questions about the content of the survey questions. They were permitted, however, to answer questions about what was required of respondents and how they should record their answers.

b Percentages relate to 22 cases where students were reported to have left the room during the survey session (see Exhibit 8.5).

Exhibit 8.7: Need to replace future teacher survey booklets (percentage of IQCM responses)

Questions	Yes (%)	No (%)	Not Answered (%)
Were any defective survey booklets detected and replaced			
• Before the survey session began?	4.7	90.6	4.7
• After the survey began?	2.4	92.9	4.7

8.2.1.2.4 Interview with the institution coordinator and survey administrator

The purpose of each IQCM's interview with the institution coordinator and survey administrator was to solicit their feedback on the surveying procedures and suggestions for improvement, and to collect relevant background information (e.g., shipment of assessment materials, arrangements for survey administration, cooperation with the NRC). IQCMs were requested to record their summaries of the interviews in Section D of the session observation record.

Overall, the institution coordinators and survey administrators expressed a favorable impression of the interviews, indicating that they went very well with few problems. However, a few (about seven percent) said they would not be willing to repeat their roles, citing difficulties with timing and motivation. Some coordinators and administrators experienced problems with completing the required forms due to lack of necessary data (especially on educators in their institutions), and with persuading the selected persons to participate in the survey. In some cases, they did not receive survey instruments in time to check for potential defects. Exhibit 8.8 provides a selection of the coordinators' and the administrators' responses.

The coordinators' and the administrators' suggestions for improvements related predominantly to the survey administration manuals (see Exhibit 8.9). Around 14 percent of the administrators stated that the TEDS-M survey administrator manual needed improvement, noting in particular the necessity for clearer timing procedures, while about six percent of the institution coordinators suggested the need for more explicit procedures for including relevant participants on the listing forms.

Important contextual information relating to the survey was solicited through a question which asked the institution coordinators to rate the attitudes of the involved institution staff members towards the TEDS-M survey. There was only one instance of an institution with staff who, according to the coordinator, held negative attitudes. In 77 percent of cases, coordinators said the survey was well received.

Approximately 39 percent of coordinators reported giving survey respondents, including the future teachers, some kind of special instruction, motivational talk, or incentive to participate (see Exhibit 8.10). These approaches usually consisted of the coordinator sending a personal email, making a phone call, or meeting with the individuals selected to participate in the surveys so they could explain the importance of TEDS-M and thank them for agreeing to participate. In a few cases, coordinators invited future teachers for drinks or a meal, or gave them small tokens in recognition of their participation in TEDS-M.

Exhibit 8.8: Summary of the institution coordinators' and survey administrators' evaluations of TEDS-M future teacher surveys (percentage of IQCM responses)

Questions	Yes (%)	No (%)	Not Answered (%)
According to the institution coordinator and survey administrator, how well did the survey go? • Very well, no problems • Satisfactorily, a few problems	94.1 70.6 23.5	2.4	3.5
Did they have time to check the shipment of materials from the TEDS-M national coordinator?	76.5	14.1	9.4
Did they receive the correct shipment of all survey instruments?	84.3	7.7	8.0
Was the national coordinator responsive to their questions or concerns?	92.9	1.2	5.9
Did they have any problems with completing the requested forms?	8.8	81.2	10.0
Were the given lists of educators and future teachers in this institution complete and accurate?	73.0	8.7	18.3
Were there any individuals relevant for this study who were not included in the lists?	8.8	75.9	15.3
If there was another international assessment, would they be willing to serve as institution coordinator/survey administrator?	84.1	7.1	8.8

Exhibit 8.9: Suggestions for improvement (percentage of IQCM responses)

Questions	Worked Well (%)	Needs Improvement (%)	Not Answered (%)
Overall, did the TEDS-M *institution coordinator manual* work well or did it need improvement?	84.7	5.9	9.4
Overall, did the TEDS-M *survey administrator manual* work well or did it need improvement?	71.8	14.1	14.1

Exhibit 8.10: Additional background information (percentage of IQCM responses)

Questions	Responses (%)
How was the attitude of the other institution staff members towards the TEDS-M survey? • Positive • Neutral • Negative • Question not answered	 76.4 16.5 1.2 5.9
How demanding were the steps required to complete the *institutional program questionnaire*? • Very easy, no problems • Satisfactory, few problems • Unsatisfactory, many problems • Question not answered	 27.5 28.5 2.5 41.5
Did any study participants receive any special instruction, motivational talk, or incentives to prepare them for the assessment? • Yes • No • Question not answered	 38.8 57.7 3.5

8.3 National Quality Control of the TEDS-M Survey Administration

The IEA Secretariat prepared and then sent to all NRCs a manual (IEA, 2007e) for the national quality control monitors (NQCMs). The Secretariat encouraged NRCs to amend the manual where they deemed necessary so that it would be relevant in terms of matters of special importance in their country. Each national center then appointed a NQCM to visit selected institutions, verify adherence to the survey administration guidelines during the data-collection session, and document all observations. The NQCMs' monitoring tasks were similar to those of the IQCMs outlined earlier in this chapter. The NRCs documented their experiences with the national quality control program on the TEDS-M survey activities questionnaire.

8.3.1 Effectiveness of the National Quality Control Program

The national quality control programs were smaller than the international one. In absolute numbers, this difference meant fewer visited institutions and observed sessions: 85 IQCM visits against 68 reported NQCM observations in total across the 13 countries responding to the questionnaire. Anywhere from one to seven NQCMs and/or assistants were appointed in each country. Most NRCs reported using the templates of the manual for national quality control monitors and the session observation record without modification. In one country, adaptations to the manual were made to accommodate national options that required additional attention.

The NQCMs confirmed the good quality of the surveying process overall, but identified some problems, similar to those reported by the IQCMs, such as logistical deficiencies, defective survey materials, errors made by some survey administrators, and unmotivated future teachers. All such matters, if impossible to rectify, were carefully documented.

8.4 Observations Reported in the Survey Activities Questionnaire

The purpose of this questionnaire was to gather information about various aspects of the participating countries' implementation of the TEDS-M survey according to the standards outlined in the survey operations procedures (IEA, 2007f). The standards focused in particular on:

- *Sampling* (contacting institutions and working with institution coordinators; institution and within-institution sampling);
- *Survey pre-administration activities* (adapting and translating materials; assembling and printing materials);
- *Survey administration activities* (administering the survey; NQCM summary);
- *Survey post-administration activities* (scoring constructed-response items; entering and submitting data);
- *Curriculum analysis activities* (syllabi collection and syllabi analysis coding); and
- *Miscellaneous* (additional feedback).

As noted in Section 8.3 of this chapter, TEDS-M required all NRCs to complete the survey activities questionnaire, and all but one did (the exception was the NRC for the Russian Federation). The NRCs completed the form personally, with assistance from the national center data manager and/or other national center staff where necessary. To make this data collection more efficient, the questionnaire was administered online.

Some NRCs reported difficulties in convincing selected institutions (eight countries) and future teachers (10 countries) to participate in the TEDS-M survey. Common reasons cited were logistical issues (timing, availability of future teachers and staff), lack of interest, and political/institutional concerns. NRCs from nine participating countries indicated that they used letters (based on a sample letter written by members of the TEDS-M international team) to request institution participation in TEDS-M. In two cases, a supporting letter from the relevant ministry was also used.

In at least 10 countries, some or all of the survey administrators came from organizations outside the sampled institution, including national center staff, graduate students, primary school teachers, and hired survey administration specialists. While many national centers held formal training sessions for their institution coordinators (nine countries) and survey administrators (also nine countries), others relied more heavily on the manuals and provided supplementary instruction by telephone and email. All of the NRCs reported that the institution coordinator and survey administration manuals were "very helpful" or "somewhat helpful" during the training process.

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CHAPTER 9:

CREATING AND CHECKING THE TEDS-M DATABASE

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9.1 Overview

Creating the TEDS-M international database (IDB) and ensuring its integrity was a complex endeavor requiring close coordination and cooperation among not only the staff at the IEA Data Processing and Research Center (IEA DPC), the TEDS-M international study centers at Michigan State University (MSU) and the Australian Council for Educational Research (ACER), but also the national research coordinators (NRCs) and the national data managers (NDMs) of the participating countries.

This chapter describes the data-entry and verification tasks undertaken by the national TEDS-M centers, the integration of sampling and response data, the data-editing and database creation procedures that the DPC implemented, and the steps that all involved centers took to confirm the integrity of the international database. The primary goals were to ensure that any national adaptations to the survey questionnaires were reflected appropriately in the codebooks and corresponding documentation, that all national information eventually conformed to the international data structure and coding schemes, and that errors such as logical inconsistencies or implausible values as a result of the response or data-capture process were minimized as much as possible. Quality control measures were applied throughout the whole process.

9.2 Data Entry and Verification at National Centers

Each national center was responsible for transcribing into computer data files the information from the questionnaires administered in its country at the institutional, educator, and future teacher levels.

9.2.1 Materials and Training

To facilitate data entry and verification, the IEA DPC supplied national centers with the Windows Data Entry Manager (WinDEM) software and supporting documentation in Unit 9 ("creating the data files") of the TEDS-M 2008 survey operations procedures manual (IEA, 2007). The DPC also held a three-day data-management seminar in Hamburg, Germany, in December 2006 prior to the field trial. The seminar covered software use, procedures for national adaptations, rules and procedures for data entry, data verification and checking, and (eventually) data submission. The seminar was specifically targeted at the national team members responsible for data management and liaising with the IEA DPC and the NDMs. A similar training session held in September 2007 before the main-study data collection provided updated information and reminders on key processes and important rules.

9.2.2 Codebook Adaptation and Data Entry

National centers entered responses from questionnaires into data files created from internationally predefined codebooks. These contained information about the names, lengths, locations, labels, valid ranges (for continuous measures or counts) or valid values (for nominal or ordinal questions), and missing codes for each variable in each type of questionnaire. Before data entry commenced, NDMs were required to adapt the codebook structure to reflect any approved adaptations made to the national versions of the questionnaires, such as a nationally added response category (see Chapter 5 of this current report). These adapted codebooks then served as templates for creating the corresponding data-entry file(s).

Data entry related to the following instruments used to survey the participating teacher preparation institutions, educators, and future teachers (see Chapters 3 and 4 of this report):

- Institutional program questionnaire;
- Educator questionnaire;
- Future teacher booklets (five rotations for the primary school level and three for the secondary level); and
- Reliability scoring sheets for responses in Section C of the future teacher booklets.

In general, the DPC instructed national centers to securely discard any questionnaires that were not administered or returned completely empty and to enter only data from those questionnaires that contained at least one valid response. Although this procedure considered such questionnaires a "response," this does not imply that they were consequently considered as "participating" (in a sampling adjudication sense). For further information, see Section 10.3 on participation rates in Chapter 10.

National staff were also required, in line with the basic rule for data entry in WinDEM, to enter data "as is," that is, without interpretation, correction, truncation, imputation, or other undue and unapproved cleaning. The resolution of any inconsistencies remaining after the data-entry stage was intentionally left to the *data-cleaning* stage at the international level (see Section 9.3 below). The overall rules for data entry were as follows:

- Responses to categorical questions were to be generally coded as "1" if the first option (checkbox) was used, "2" if the second option was marked, and so on.
- Responses to "check-all-that-apply" questions were to be coded as either "1" (checked) or "2" (not checked), and also in cases where all options were unchecked in the questionnaire.
- Responses to numerical or scale questions (e.g., school enrolment) were to be entered "as is," that is, without any correction or truncation, even if the value was outside the originally expected range. However, data-entry staff were prompted to explicitly confirm the value in these cases.

- Likewise, responses to filter questions and filter-dependent questions were to be entered exactly as filled in by the respondent, even if the information provided was logically inconsistent or otherwise implausible.
- In cases of responses not being given at all, not given in the expected format, ambiguous, or in any other way conflicting (e.g., selection of two options in a multiple-choice question) and not able to be recovered after consulting with the IEA DPC, the corresponding variable was to be coded as "omitted."
- In cases of misprinted questions or pages, a separate code called "not administered" was to be used.

Once data had been entered with WinDEM, they were automatically validated. First, each entered respondent ID was validated against a "checksum," a three-digit code generated by Within-institution Sampling Software (WinW3S) during sample selection. A mistype in either the ID or the checksum resulted in an error message that prompted the data-entry person to check the entered values. Second, data were systematically checked for duplicate identification codes as well as for data values outside the expected valid range or values not among the list of defined values (termed "wild codes"). A so-called "column shift check" at the end of every odd-numbered page helped data-entry staff verify and synchronize their position in the data-entry system with the position in the instrument. If a column shift occurred, staff were instructed to review and correct all values entered after the last correct column shift check.

The IEA DPC strongly encouraged every country to use the WinDEM software for manual data entry in order to meet all standards and benefit from the above-mentioned automatic checks. Several countries used alternative data-capture systems routinely utilized by contracted survey organizations (Canada, Singapore, and Spain) or an existing inhouse system (United States). After the IEA DPC reviewed and approved these proposed deviations, these countries were nonetheless required to conform to all specifications established in the international codebooks and all data-entry rules, eventually transfer data to WinDEM, and then verify this information using the same set of consistency and validation checks used by all other countries. The IEA DPC checked and confirmed the consistency and quality of the data captured by the four countries and did not detect any systematic or incidental issues.

The following additional deviations from the standard data-capture procedures occurred.

- Only one institutional program questionnaire was administered per institution in Canada given the extreme similarity of the teacher preparation units (TPUs) in it. The remaining data records were created later, and all values, with the exception of one question (MIB003), were copied to these records from the administered questionnaire. The Canadian NRC explicitly verified all values and provided the values for this question that varied across the TPUs in the same institution.
- Norway administered the educator questionnaire using an unapproved online questionnaire system. While data were as successfully converted as if they had been entered in WinDEM, the DPC adjudicated these data as unacceptable because it was impossible to reliably link them to sample design information.
- United States data for future teachers contained a number of records (23% for the primary level, 18% for the secondary level) that were administered and captured through unapproved procedures (partial collection). Corresponding annotations were made in the reporting of these data.

9.2.3 Double Data Entry (Quality Control)

For the TEDS-M 2008 main study, the IEA DPC required a random sample of five percent of instruments per instrument type (but including at least 50 instruments of each type) to be entered twice. This meant that two different data-entry persons entered the same five percent of instruments (but at least 50 of them) into two separate data files. To do this, NDMs were asked to create two copies of each data file, with one file treated as the original, and the other one as the control file. Once data-entry staff had entered these instruments in both files, NDMs ran a data-entry quality procedure in WinDEM, crosschecking that the values of all variables of the record in the first file matched the values of all variables of the record with the same unique identifier in the second file. The DPC asked the NDMs to initially check the reliability of the data entry as early as possible during the data capture, and then on a regular basis. This procedure allowed NDMs and the IEA DPC to identify possible systematic or incidental misunderstandings or mishandlings of data-entry rules and to initiate appropriate reactions, for example, retraining staff within national centers.

An error rate of 1.0 percent or less was regarded as acceptable for the institutional program and educator files. An error rate of 0.1 percent or less (due to item/block rotation) was accepted for the future teacher data files. Above this level, the IEA DPC would have requested a complete re-entry of data. The margin of error observed for all countries participating in the main data collection was well below these thresholds.

9.2.4 Data Verification and Submission

Before sending data to the IEA DPC for further processing, NDMs again carried out a set of mandatory verification steps on all entered data and undertook corrections as necessary. NDMs reviewed the corresponding reports produced by the software package for data capture (WinDEM), resolving any inconsistencies and, where possible, correcting problems by looking up the original survey questionnaires or documentation. Additionally, NDMs verified that all returned and nonempty questionnaires were in fact entered and that the availability of data corresponded to the participation indicator variables and entries on the tracking forms. Finally, the NDMs used the information stored in WinW3S and on tracking forms to verify the completeness of the materials and data records.

The national centers then submitted the data files described above as well as the finalized and exported WinW3S database. They used an encrypted and secure FTP (file transfer protocol) connection to do so. Centers also provided the ISCs and the IEA DPC with any required documentation necessary to process the data files. The deadline for submitting data for the southern hemisphere was set for February 2008 (given that data collection was scheduled to conclude at the end of November 2007). The deadline for the northern hemisphere was set for the end of August 2008 (data collection ending in May 2008).

Having submitted their data, NRCs were then asked to report on data-capture and quality-control activities, using the relevant part of the online survey activities questionnaire to do so. In their responses, NRCs flagged no major concerns or problems regarding the data management.

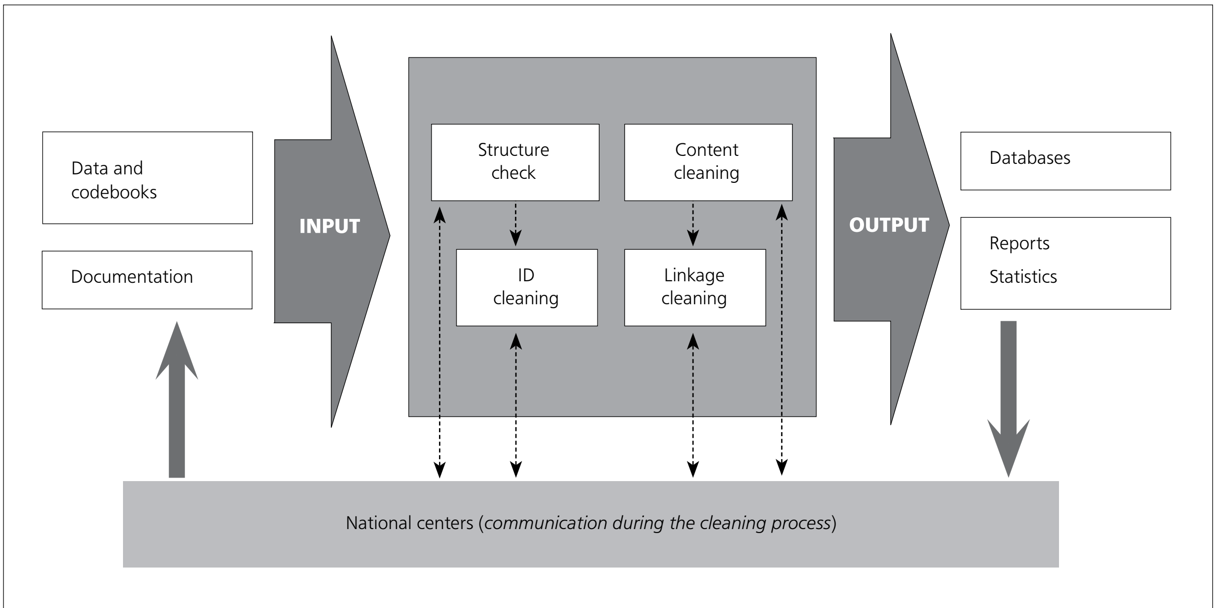
9.3 Data Checking, Editing, and Quality Control at the IEA DPC

Once the national centers had submitted their data to the IEA DPC, data processing and cleaning commenced. In order to document data versions and updates, all incoming data and documents were registered in a materials receipt database. The date of arrival was recorded, along with any specific issues meriting attention.

A complex study such as TEDS-M required a correspondingly complex data-cleaning design. The IEA DPC developed data-processing tools in SAS version 9.1.3 (SAS Institute Inc., 2008). Before being used with real data, all data-processing programs were thoroughly tested using simulated datasets containing the majority of expected problems or inconsistencies. The IEA DPC went to great lengths to ensure that the data received from participating countries were internationally comparable and of high quality. The objective of the process was to ensure a reduction in or the elimination of data-processing errors so that the data adhered to international formats, information could be reliably linked across different survey files, and the data accurately and consistently reflected the information collected within each participating country.

Exhibit 9.1 provides a schematic overview of this iterative process conducted in cooperation with the national centers. The following sections describe in more detail the sequential data-cleaning steps displayed in the exhibit.

Exhibit 9.1: Overview of iterative data processing at the IEA DPC



9.3.1 Import and Structure Checks

Data cleaning began with a review of the submitted data files and any applicable data documentation. Next, all available codebooks and data were imported from the source files and combined into SAS databases. Each questionnaire type corresponded to one SAS database and one SAS codebook file. During the next step of the import, the data captured from paper instruments were merged with sample data recorded in the WinW3S database (see Chapter 7 of this report).

DPC staff next conducted a "structure check," which involved looking for differences between the international and the national file structures. Elements looked for and identified included:

- International variables missing or hidden in the national data files;
- National variables added in the national data files;
- Change of variable order, type, class, name, or label;
- Change of variable length and/or number of decimals;
- Different number, order, or labels of response categories for categorical/discrete questions; and
- Different coding schemes or validations for numerical/continuous questions.

All identified deviations were compared and crosschecked against the national adaptation forms, the national codebooks, the national instruments, and the data itself. The results and actions undertaken during this step were presented in reports. In cases of unexplained data-structure changes, the relevant NRC and/or the international study center were contacted for advice, justifications, and explanations.

9.3.2 Handling Adapted and National Variables

While all TEDS-M participating countries made mandatory and optional structural adaptations to the questionnaires, the extent and nature of these changes differed greatly across the countries. Some countries administered the questionnaires without major changes, except for translations and necessary cultural adaptations; others inserted questions or options. Given the associated risk of deviating from the international data structure, NRCs wishing to make such changes followed strict rules to allow unequivocal integration of nationally adapted variables for international comparison.

In general, few adaptations were made to the international questionnaires. Where necessary, the IEA DPC modified values to ensure that the resulting data were internationally comparable and provided the respective NRCs with detailed documentation of this procedure. For instance, additional national options in multiple-choice questions were recoded (mapped) in such a way that they again adhered to the international code scheme. National variables were created to hold the original values for later use in national reports. In a few cases, data were not available for certain variables because the corresponding question was not administered nationally. All national adaptations and all detected deviations from the international data structure were recorded in a national adaptation database (NADB).

9.3.3 Cleaning of Identification Variables and Linkage

To uniquely identify, track, and document each respondent and each corresponding questionnaire in a survey, each record in a data file needed to have a unique identification (ID) variable. The existence of records without an ID or with a duplicate ID number implied an error of some kind. If, in TEDS-M, two records shared the same ID number and contained exactly the same data, one of the records was deleted and the other remained in the database. If the records contained different data (apart from the ID numbers), and it was impossible to identify which record contained the "correct" data even after consultations with the relevant NDM, both records were removed from the database. Overall, the IEA DPC deleted data in only a very small number of cases.

In TEDS-M, institutions served as containers for all data collected within them. For this reason, all data records in TEDS-M can be associated with an institution. Future teachers were uniquely and directly associated with one and only one teacher preparation unit (TPU) via a hierarchical ID numbering system. Educators were associated with one, many, or all TPUs within an institution. The DPC recorded this many-to-many link as a special comma-separated ID variable (TPUIDS).

Linkage cleaning also involved looking at and, where necessary, correcting the integrity of records between the data used for listing, sampling, and tracking in WinW3S and the actual responses in the questionnaires. This type of cleaning furthermore involved checking not only the availability of main and reliability scores for future teachers marked for double scoring but also the consistency of the assigned and actually administered booklet rotation for future teachers. DPC staff also crosschecked data between education system levels and corrected any identified inconsistencies in the linkage between files. The DPC then sent the TEDS-M national centers standardized reports detailing each identified inconsistency and the implemented edit.

9.3.4 Questionnaire Data Cleaning

Once the DPC was assured that each data file matched the specifications in the international codebooks, staff applied a set of standard cleaning rules to the files (IEA, 2009). The process, conducted via SAS programs developed at the IEA DPC (SAS Institute Inc., 2008), involved identifying and, in appropriate cases, automatically correcting inconsistencies in the data.

Split-variable checks were applied to "yes/no" lists and "check-all-that-apply" questions for which responses had been coded into several variables. For example, Question 4 in Section A of the future teacher questionnaire listed a number of home possessions and asked respondents to state whether they had them by checking "yes" or "no." Occasionally, respondents marked just the "yes" boxes and left some of the "no" boxes unchecked, resulting in "omitted" values in the data file. In these cases, it was assumed that the unmarked boxes actually meant no, and the corresponding variables were coded accordingly.

Filter questions, which appeared in certain positions in the TEDS-M questionnaires, were used to direct respondents to a particular question or section of a questionnaire. Filter questions and their dependent questions were treated automatically, in most cases according to the following sequence:

- If the filter question was coded to "no" or if it was omitted but dependent questions were answered and provided more information, then the filter was recoded to "yes/ applicable."
- If the filter question was still coded to "no" (meaning that all dependent questions were omitted), then all dependent questions were recoded to a newly introduced missing value—"logically not applicable."
- If the filter question was omitted and the dependent questions were coded to "not administered," then the dependent questions were also recoded to "omitted."

Responses to questions asking for multiple percentages or integer values were also reviewed. Omitted values in questions asking for counts for which other values were stated were coded to zero (0). Percentage sums outside the 95 to 105 range were flagged for review by the IEA DPC and the TEDS-M countries.

The number of inconsistent or implausible responses in the data files varied from one country to another, but no national data were completely free of inconsistent responses. Each problem was recorded in a database, where it was identified by a unique problem number along with a description of the problem and the automatic action taken by the program or the manual action taken by DPC staff. Issues that could not be corrected using systematic rules were reported to the respective NDMs so that original instruments and tracking forms could be checked to trace the source of the inconsistency (e.g., a data-entry mistake). Whenever possible, staff at the IEA DPC suggested a solution and asked the NDMs to accept it or to propose an alternative. Data files were then updated to reflect the agreed solutions. Systematic as well as case-level corrections were applied directly in SAS program syntax and carried out automatically for each cleaning run.

Where countries could not solve problems or suggest a satisfying explanation, final cleaning rules were defined. In TEDS-M, this procedure affected only the educational attainment of father/mother (variables MFA005/MFA006) in the future teacher booklet. Here, Categories 7 ("<ISCED 5A>, second degree") and 8 ("Beyond <ISCED 5A>, first degree") were collapsed for all countries because of a possible overlap in category semantics, and the original values were stored in national variables. In other instances, clear and unambiguous decisions were generally not possible. In these cases, the data remained unchanged and data users were asked to carefully review the variables of interest for any remaining outlying as well as implausible values or combinations that might either warrant edits prior to the analysis of findings or special attention during the interpretation of findings.

9.3.5 Handling of Missing Data

A response to a question can be missing for several reasons. The question may have been deliberately excluded from the questionnaire ("not administered") or the respondent may have chosen not to respond to the question ("omitted"), may have skipped a question due to filter and flow logic ("logically not applicable"), or simply did not have time to reach the item in the cognitive section of the instrument ("not reached").

During the TEDS-M data entry via WinDEM at the national centers, data-entry operators could assign either a valid value or two types of missing value:

- *Omitted/invalid:* The respondent had the opportunity to respond to the question, but did not do so or provided an invalid response. The code for "omitted/invalid" responses in SPSS files is "9," "99," "999," and so on (depending on the field length of the variable) and is system missing "." in SAS.
- *Not administered:* The question was left out or misprinted in a specific copy of an instrument. The code for "not administered" questions is "SYSMIS" (.) in SPSS files and ".A" in SAS files.

During the data processing at the IEA DPC, additional types of missing values were applied to the data for further analyses and to differentiate response behavior.

- *Logically not applicable* (applied to the institutional program and educator questionnaires as well as Parts A, B, and D of the future teacher booklets): Here, a previous filter question would have been answered in a way that made a response to one or more dependent questions logically impossible. In other words, the respondent skipped the dependent questions. The code for "logically not applicable" responses in SPSS is "6," "96," "996," and so on (depending on the field length of the variable). The code for logically not applicable responses is ".B" in SAS files.

- *Not reached* (applied only to Part C of the future teacher booklets): A special missing code was assigned to questions that were deemed "not reached" in order to further distinguish them from omitted responses during item calibration and scoring. In SPSS files, "not reached" variables are coded as "6," "96," "996," and so on (depending on the field length of the variable). The code for "not reached" is ".R" in SAS data files.

9.3.6 Interim Data Products and Reports

Building the TEDS-M database was an iterative process during which the IEA DPC provided the TEDS-M international team and NRCs with a new version of data files whenever a major step in the data processing was completed.

The first main-study data version included 9 of the 17 countries and was produced towards the end of 2008. During the first calendar quarter of 2009, data for the remaining countries were received, processed, cleaned, and weighted. At this stage, all detected and known identification, linkage, and content issues were resolved. Once the data had been processed to this extent, they were transferred to the IEA DPC's sampling unit for calculation of participation rates, exclusion rates, sampling weights, and variables facilitating variance estimation. This stage resulted in a set of sampling/weighting-related variables that were added to each file (see Chapter 10).

Distribution of the first data version gave NRCs a chance to review their country data and to run additional plausibility and statistical checks to validate the data. The international centers were able to verify the integrity of the data from an analysis and reporting perspective. NRCs were able to raise any remaining issues concerning their data that had thus far gone unnoticed before or during the fifth (March 2009) and sixth (July 2009) NRC meetings. Databases were updated accordingly, and a second, updated data version that concluded the data-collection work was produced in August 2009. The TEDS-M international team and its partners used this version of the data as the basis for analysis and the production of displays and reports.

All interim data products were accompanied by detailed data-processing and data-weighting documentation (TEDS-M, 2009), codebooks, summary statistics (referred to as almanacs), cleaning reports, and recoding syntax, as well as cognitive item and scoring reliability statistics. These summaries were used for a more indepth review of the data at the international and national levels in terms of plausibility, unexpected response patterns, suspicious profiles, and so on.

Interim data products were made available to the TEDS-M international team in full whereas each participating country received its own data only. By default, all data files were released in fully labeled SPSS format. SAS format and raw text file formats were made available on request.

9.4 Building the International Database (IDB)

After completing data cleaning and weighting, the TEDS-M international team assembled, verified, and released different versions of the international database to analysts and the TEDS-M participating countries.

9.4.1 Removing Cases and Units Not Intended for Analysis

The interim data products described above were mainly used to verify that the data collection had been complete and accurate. Consequently, all interim products included, regardless of whether a corresponding instrument was completed or not, one record for each sampled unit (i.e., future primary teachers, educators, etc.). In contrast, the IDB included only records that satisfied the sampling standards. Data from those units that either did not participate or did not pass data and sample adjudication (e.g., because the within-institution participation was insufficient) and were consequently not to be used in the analysis, were dropped from the files. For details on data adjudication, please refer to Chapter 10.

However, data for the following samples were retained in the data archive for use by interested NRCs for further research even though the adjudication determined that they were unacceptable for international estimation, comparison, and reporting purposes.

- Canada: all samples;
- Norway: educators;
- Poland: out-of-scope educators and future teachers in second-cycle programs;
- United States: educators.

The TEDS-M international team and the NRCs received clear advice that these samples should not be reported together with the corresponding data from the other TEDS-M countries.

9.4.2 Merging Reporting Variables

As a result of psychometric analysis, a small number of derived prescored (item-level) variables were added to the international future teacher data files while a number of cognitive items excluded from calibration and scoring for all countries were set to "not administered." Also at this stage, all scale-score variables relating to opportunities to learn, beliefs, and mathematical and pedagogical content knowledge were added to the data files along with any other reporting variables such as program-type groupings. For a detailed account of these variables, please refer to Section 2.2.6 of the TEDS-M international database user guide (Brese & Tatto, 2012).

9.4.3 Ensuring the Confidentiality of Information

A particularly important issue in surveys is to preserve the confidentiality of individual respondents during the production and release of micro-datasets. A common challenge is to prevent the unintended or indirect disclosure that can occur if the release of a file leads to or allows identification of a respondent. All other matters being equal, the risk of such disclosure is greatest in cases where the combined characteristics of a respondent in the data lead to a unique individual in the population. The higher the sampling fraction and participation is, the more likely it is that a unique record in the sample will also be unique in the population. In TEDS-M, special challenges arose from the relatively small size of the surveyed populations and the fact that the entire population or cohort was selected for participation in a number of countries.

The TEDS-M analysis team received the entire database without any censoring, perturbation, coarsening, masking, or restrictions. Likewise, each NRC received his or her own country's data without restrictions or confidentiality measures applied. Releases of any dataset beyond the concerned country, initially to all other participating countries and later to interested scientific users (the "NRC-use IDB" and the "scientific-use IDB" respectively; see below) were subjected to a set of disclosure-avoidance measures applied consistently to all countries as well as a set of individual measures concerning only specific national datasets. These measures were agreed on during discussions between the NRCs, the ISC at MSU, the IEA Secretariat, and the IEA DPC. They were then implemented centrally by the IEA DPC.

In seeking to manage the risk of disclosure, the TEDS-M team required a number of modifications to be universally applied to the data in all countries. These modifications meant that:

- The international TEDS-M data included no direct identifiers for the individual respondents such as names and telephone numbers but instead held only the identification numbers used during the field work. These unique identifiers were scrambled and consequently no longer matched those used during data collection. New random sequential numbers were created for any primary sampling units (PSUs), and sequential numbers within a PSU (e.g., for educators) were assigned, starting with 1 and extending to a value equivalent to the number of records in the unit. All structural links between files were maintained so that hierarchical IDs could be changed consistently within and across all files. For each country and file type, the IEA DPC created a unique matching table and made it available to the respective NRC only. The scrambling of IDs had no effect on the utility of the micro-data for secondary analysis.
- Variables used for logistical or temporary purposes, such as a data-entry operator ID, were deleted. The removal of these variables had no effect on the analytical utility of the micro-data.
- Variables used purely for explicit or implicit stratification at the PSU level were removed to avoid identification of geographical and organizational groups. The stratum information was mostly of interest for national-level analysis and was always available to the respective NRC. The removal of these variables limited the analytical utility of the micro-data to a minor extent. However, the stratification variables could be requested directly from the concerned NRC.
- Variables used purely for stratifying the sampling frames within PSUs, such as the age and gender of educators, were removed. This practice had no negative impact on the analytical utility of the files because the questionnaires also collected corresponding information for educators and future teachers.
- Information used during the calculation of final sampling weights (base weights, weighting factors, and no response adjustments) was removed because of the possibility of reidentification of stratification cells. Removal of this information had no negative effect on the analytical utility of the micro-data because all information about the weighting factors and adjustment was fully contained in the final and replicate weights on the file.
- Replication zone and unit variables used only during the computation of replicate weights were also dropped from the micro-data because of the potential for indirect identification of PSUs. Their deletion had no negative effect on the analytical utility of the micro-data because all information about the zone and unit assignments was fully contained in the set of replicate weights on the file.

Germany and Switzerland requested additional confidentiality measures in relation to a few variables with a higher disclosure risk, and these were applied to the respective national datasets. The original variables were set to "not administered," categorical values were recoded to a shorter list of values, and extreme values were recoded to the mean value of the group showing an extreme characteristic (such as future teacher age).

While the clear text names in the database for future teacher programs (variable TPUPROGR) were not a direct identifier in the true sense of the word, their inclusion in the NRC/scientific-use databases increased the chances of indirect identification of institutions offering a particular program. The TEDS-M joint management committee as well as the NRCs considered this variable to be essential for conducting meaningful secondary analysis and argued that it could not be removed without seriously reducing the analytical utility of the database. It was therefore proposed and agreed to retain the variable in the dataset but to specifically state in a confidentiality undertaking or affidavit that any user of the NRC or research-use databases must refrain from reidentifying institutions and from reporting them individually using their names.

9.4.4 International Database for NRC Use

In December 2009, the IEA DPC released a confidential draft international database (IDB) specifically for NRC use. This release, conditional on a data-release policy and under embargo, occurred prior to publication of the international report and enabled countries to prepare national reports and replicate analyses undertaken for the drafts of the international report. NRCs had to explicitly confirm that they had read, understood, and agreed to be bound by the terms, restrictions, and conditions of the data-release policy.

More specifically, the terms of the policy stated that NRCs must not make the IDB accessible to any third party, and that they must not match any records, other than those pertaining to their own country, to any other data files because of the risk of reidentifying the survey units on the files. The policy terms also required NRCs to ensure that all outputs and publications referred to aggregated data only and did not therefore reveal information regarding individual sampled units. The embargo relating to the release of any international results was lifted on 15 April 2010. The data files, however, continued to be confidential. Late in 2010, NRCs received the final NRC-use database containing all necessary corrections.

9.4.5 International Database for Scientific Use

Third parties, such as researchers wanting to carry out secondary analyses of TEDS-M data, can access the scientific-use IDB on request and subject to their signing an affidavit of nondisclosure and a user agreement between them and IEA. A user guide (Brese & Tatto, 2012) provides a detailed description of the IDB data files and their variables and coding. It also offers advice and support on using IEA's IDB Analyzer to analyze the complex sample data in TEDS-M.

References

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CHAPTER 10:

ESTIMATION OF WEIGHTS, PARTICIPATION RATES, AND SAMPLING ERROR

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10.1 Overview

The selection of probabilistic samples of institutions, future primary teachers and lower-secondary teachers, and their educators was a key component of the TEDS-M survey. As an essential part of their sampling activities, NRCs were responsible for providing detailed documentation describing their national sampling plans (structure of mathematics teacher education and educational institutions, including measures of size and the institution sampling frame). While the IEA Data Processing and Research Center (DPC) was responsible for selecting the samples of institutions, national teams were responsible for selecting the samples of future teachers and educators within selected institutions. They used the Within-institution Sampling Software for Windows (WinW3S) provided by the IEA DPC to carry out this work. The sampling team at the DPC then reviewed and completed all sampling documentations, including details relating to coverage and exclusions, and stratification. This documentation was also used to evaluate the quality of the samples.[1]

This chapter covers three important aspects of the quality of the TEDS-M outcomes: the weighting of the data to produce the population estimates, the participation rates, and the estimation of sampling error. Although the international sampling plan was prepared as a self-weighting design, where each individual would have the same final estimation weight, conditions in the field, such as nonresponse, made execution of that ideal plan impossible. In the end, each national sampling plan was unique, ranging from a stratified multistage probability sampling plan with unequal probabilities of selection to a simple and complete census of all units of interest (see Appendix C).

Section 10.2 describes how each component of the final estimation weight for each TEDS-M population was defined and how those components were assembled into the final estimation weight. Section 10.3 describes the participation rates and their computations. The participation rates for each country are also displayed in this section.

Because, compared with a simple random sample, a complex sample design and unequal weights change the sampling error, the latter must be estimated by taking the complex sample design and the unequal weights into account. Failure to do so can produce severely biased estimates of sampling error. TEDS-M therefore adopted the balanced repeated replication (BRR) technique (McCarthy, 1966). The particular variant used is known as Fay's method (Fay, 1989), a technique that is well documented and also used in other international educational studies, such as the Programme for International Student Assessment (PISA) and the Teaching and Learning International Survey (TALIS), both of which are conducted by the Organisation for Economic

1 Further details on the sampling design appear in Chapter 6 of this technical report.

Co-operation and Development (see OECD, 2006, 2007). Section 10.4 explains how the replicates were created and how the BRR estimates of sampling error were computed. These estimates of the sampling error are another key element of the statistical quality of survey outcomes.

A detailed description of the TEDS-M survey design and its recommended implementation can be found in the TEDS-M sample preparation manual (IEA, 2006a) and in the TEDS-M survey operations procedures (IEA, 2006b), as well as in Chapters 6 and 7 of this current report.

10.2. Computing the Estimation (or Final) Weight

Most of the statistics produced for TEDS-M were derived from data obtained through samples of institutions, teacher educators, and future primary school and lower-secondary school teachers being prepared to teach mathematics. If these statistics were to be meaningful for a country, they needed to reflect the whole population from which they were drawn and not merely the sample used to collect them.

In the TEDS-M countries where censuses were conducted, it was sufficient to adjust the collected data for nonresponse[2] in order to obtain unbiased estimates of the population parameters. However, when the sample design was complex and involved stratification and unequal probabilities of selection, estimation weights were required to achieve unbiased estimates (Lohr, 1999).

The *estimation* or *final weight* is the device that allows the production of country-level estimates from the observed sample data. It indicates how many population units are represented by a sampled unit. The estimation weight is the combination of many factors reflecting the probabilities of selection at the various stages of sampling and the response obtained at each stage. Basically, estimation weights are the product of one or more *design* or *base weights* and one or more *adjustment factors*. The former is the inverse of the selection probability at each selection stage; the latter compensates for nonresponse. These design weights and adjustment factors are specific to each stage of the sample design and to each explicit stratum. Clearly, since each country participating in TEDS-M had to adapt the general sample design of TEDS-M to its own conditions, the estimation weights had to conform to these national adaptations.

Usually, one set of estimation weights would be produced for each country participating in a survey. However, in the case of TEDS-M, four sets of estimation weights were required to reflect the various surveys comprising the study: the institutions, the educators, the future teachers of mathematics at the primary school level, and the future teachers of mathematics at the lower-secondary school level.

The following are the conventional notations used throughout this chapter (refer also to Exhibit 10.1): h, i, k, j, g, l, t, and d are used as subscripts, lower-case letters (n, e, f, s, r, p, q, v) refer to the sample or the participants, and the upper-case letters (M, H, N, K, E, G, Q, F, S) refer to the population.

- In each participating country, there were H explicit strata; the index $h = 1, \ldots, H$ pointed to the explicit stratum; if no explicit strata were defined, then $H = 1$.

2 Under the hypothesis of noninformative response model, or that items are "missing completely at random."

- In each explicit stratum, a sample of size n_h institutions was drawn from the N_h institutions comprising stratum h; the index $I = 1, \ldots, n_h$ pointed to the i^{th} sampled institution in stratum h. In the case of a census, $n_h = N_h$.
- Each institution had a measure of size (MOS) that was usually the number of future teachers in their final year, noted as M_{hi}. Within the explicit stratum h, the sum of these size measures was noted as M_h; in the case of simple random sampling, all M_{hi} were set to 1 and thus $M_h = N_h$, that is, the number of institutions in the explicit stratum.
- All teacher preparation units (TPUs) $l = 1, \ldots, Q_{hi}$ found in an institution were automatically selected.
- In each responding institution, within each TPU, several samples were drawn:
  - A sample of s_{hil} session groups was drawn and all future teachers F_{hild} were automatically selected within these session groups. The index $d = 1, \ldots, s_{hil}$ pointed to the session groups.

  Or

  - One single session group per TPU was created, and a sample of f_{hild} future teachers was drawn out of F_{hild} future teachers, $d = 1$. If the selected institution was large enough, $f_{hild} = 30$ (per TPU) by design; the index $t = 1, \ldots, f_{hild}$ pointed to the future teachers. However, f_{hild} could differ from 30 if local conditions dictated that the sample size should be different. So, for example, if the MOS was 23, all future teachers were selected and $f_{hild} = 23$.

  Moreover,

  - A sample of e_{hig} educators was drawn. If the selected institution was large enough, $e_{hig} = 30$ per educator-group g by design. The index $j = 1, \ldots, e_{hig}$ pointed to the educator; e_{hig} could differ from 30 if local conditions dictated that the sample size should be different. Thus, for example, if the number of educators in an educator-group was 20, all educators were selected and $e_{hig} = 20$.

Exhibit 10.1: Conventional notations used in this chapter

Unit	Indices	Units Participating	Units Sampled	Units in Population
Explicit stratum	*h*			*H*
Measure of size				*M*
Institution	*i*	*r*	*n*	*N*
Route-level combination	*k*			*K*
Educators	*j*	*p*	*e*	*E*
Educator-group	*g*			*G*
TPU	*l*	*q*		*Q*
Future teacher	*t*	*v*	*f*	*F*
Session group	*d*		*s*	*S*

10.2.1 Institution Base Weight (Institution Design Weight)

The first stage of sampling in TEDS-M was the sampling of institutions. As noted above, in many of the participating countries, or explicit strata of a country, the sample of institutions was a census sample; in other countries, or explicit strata of a country, the sample of institutions was drawn according to a systematic random sampling scheme with selection probabilities proportional to size (PPS). When a census sample of institutions was implemented in a country or in an explicit stratum of a country, the institution base weight was set to 1. Use of the notation provided above gave the institution base weight as

$$WGTFAC1_{hi} = \begin{cases} 1 & \text{for censuses} \\ \dfrac{M_h}{n_h \times M_{hi}} & \text{for random samples} \end{cases}$$

for each institution $i = 1, \ldots, n_h$ and each explicit stratum $h = 1, \ldots, H$. The institution base weight was computed once and then fixed, irrespective of which of the subsequent four different target populations of TEDS-M was concerned.

10.2.2 Institution Nonresponse Adjustment Factor

Despite all efforts to secure the full participation of all selected institutions and their members, some were unable or unwilling to participate. Those institutions where the participation of individuals was below 50 percent were deemed to be nonparticipating for the respective population of interest. However, the institutions that were represented by the nonparticipating institutions still had to be represented. Therefore, a nonresponse adjustment factor was required within each explicit stratum. Given the multiplicity of types of respondents in TEDS-M, a different institution nonresponse adjustment factor was required for the educators, the future teachers of mathematics at the primary level, and the future teachers of mathematics at the lower-secondary level.

For each explicit stratum $h = 1, \ldots, H$. If r_h out of the n_h selected institutions participated in TEDS M, the nonresponse adjustment factor was given as

$$WGTADJ1_h = \begin{cases} \dfrac{n_h}{r_h}, & \text{for participating institutions} \\ 0 & \text{for nonparticipating institutions} \end{cases}$$

with the acknowledgment that if the form was identical, the value of the adjustment factor could change according to the population of interest.

10.2.3 Final Institution Weight

The final institution weight was the product of the institution base weight and the institution nonresponse adjustment factor. For each participating institution $i = 1, \ldots, r_h$, and each explicit stratum $h = 1, \ldots, H$, the institution final weight was given as

$$\begin{aligned} INSWGT_{hi} &= WGTFAC1_{hi} \times WGTADJ1_h \\ &= \frac{F_h}{n_h \times F_{hi}} \times \frac{n_h}{r_h} \\ &= \frac{F_h}{r_h \times F_{hi}}. \end{aligned}$$

The different populations of interest in TEDS-M meant that the final institution weight for each population of interest had the potential to change according to the level of participation of the respective group of individuals. This possibility is reflected in the population identifier attached to each of the final institution weights in the respective file of the international database (INSWGT**I**, INSWGT**E**, INSWGT**P**, INSWGT**S**).[3] The TEDS-M team therefore had to use the appropriate final institution weight for all estimates pertaining to institution-specific features.

10.2.4 Teacher Preparation Unit Nonresponse Adjustment Factor

For operational purposes, TEDS-M divided each institution in the sample into subgroups of future teachers that were defined by the combination of the level (primary, lower secondary), the route (concurrent, consecutive), and the specific program-type. These subgroups were called "teacher preparation units" (TPUs) or programs (refer also to Chapter 7 in this report). Because, within each selected institution, all TPUs were automatically selected to participate in the survey, there was no need to apply a TPU base weight (because it would always be equal to 1).

TEDS-M asked each selected institution to complete one institutional program questionnaire (IPQ) for each TPU. The data from these questionnaires were stored in the institution files ("DIG files") of the international database (IDB). Despite every effort to gather up all requested IPQs from the participating institutions, there were instances of questionnaires not being completed for one or some TPUs. The TEDS-M team therefore had to calculate a TPU nonresponse adjustment factor. This adjustment was done within explicit strata, across institutions, but within the level x route combination. Thus, there was a need to adjust the estimation weight for, say, all concurrent primary TPUs within one explicit stratum that responded to the IPQ, in order to account for those that did not respond.

For each explicit stratum $h = 1,...,H$ and each route × level combination $k = 1, \ldots, K_h$, if q_{hk} TPUs participated in TEDS M out of the Q_{hk} identified (and therefore selected) TPUs, then the nonresponse adjustment factor was given as

$$WGTADJ2I_{hk} = \begin{cases} \dfrac{Q_{hk}}{q_{hk}}, & \text{for responding TPUs} \\ 0, & \text{for nonresponding TPUs.} \end{cases}$$

10.2.5 Final Teacher Preparation Unit Weight

The final TPU weight was the product of the institution base weight, the institution nonresponse adjustment factor, and the TPU nonresponse adjustment factor. For each responding TPU $l = 1, \ldots, q_{hk}$ in each route × level combination $k = 1, \ldots, K_h$, and each explicit stratum $h = 1, \ldots,$ H, the final TPU weight was given as

$$\begin{aligned} FINWGTI_{hikl} &= WGTFAC1_{hi} \times WGTADJ1_h \times WGTADJ2I_{hk} \\ &= \frac{F_h}{n_h \times F_{hi}} \times \frac{n_h}{r_h} \times \frac{Q_{hk}}{q_{hk}} \\ &= \frac{F_h}{r_h \times F_{hi}} \times \frac{Q_{hk}}{q_{hk}}. \end{aligned}$$

3 Please refer to the TEDS-M IDB user guide (Brese & Tatto, 2012) for further information.

Because the final TPU weight can be found only in the institution file (DIG), it is necessary to use the final TPU weight for all estimates pertaining to data from the IPQs.

10.2.6 Session Group Base Weight

As explained in Chapter 7, each institution in the sample was divided, for operational purposes, into subgroups of future teachers called TPUs. Because TEDS-M asked each TPU in a selected institution to participate and because the participation status of an institution was determined at the institutional level only (i.e., not on the TPU level), there was no need to apply a TPU base weight or a TPU nonresponse adjustment factor.

However, within each TPU, it was possible to divide future teachers into further subgroups called session groups for organizational purposes and (in rare instances) to select only some session groups from a list of session groups according to the national sampling plan. This selection step had to be taken into account during calculation of the final future teacher weight. For many participating countries, the TEDS-M team decided not to select (some out of many) session groups but rather individual future teachers from an exhaustive list of all future teachers within one TPU. In these instances, the team created one single session group and set its base weight to 1. It needs to be noted here that the session groups were mutually exclusive and exhaustive groups. This meant that every eligible future teacher in an institution had to be allocated to one (and only one) session group.

For each session group $d=1,...,s_{hil}$ in each TPU l=1, ...,Q_{hi} from institution $i=1,...,n_h$ in explicit stratum $h=1,...,H,$ the session group base weight was given as

$$WGTAFC2_{hild} = \begin{cases} \dfrac{S_{hil}}{s_{hil}}, & \text{for TPUs with session group sampling} \\ 1 & \text{for censuses or TPUs with individual future teacher sampling.} \end{cases}$$

The two populations of interest (future teachers of primary schools and future teachers of lower-secondary schools) meant that the TEDS-M team needed to calculate the session group base weight separately for both target populations. This is reflected by attaching a population identifier to the session-group base weight in the respective file of the international database (WGTFAC2**P** and WGTFAC2**S**).

Given that it was operationally impossible to set a whole-session group to nonresponding, there was no need to calculate a session-group nonresponse adjustment factor. Therefore, the nonresponse adjustment was calculated at the future teacher level only, even if none of the future teachers within one whole session group responded to the survey.

10.2.7 Future Teacher Base Weight

In institutions where no session group sampling was conducted, the TEDS-M team selected systematic random samples of future teachers with equal probabilities from each TPU (at least 30 future teachers by design).[4] The team used the future teacher base weight (or design weight) to bring the individual future teacher's information to the level of his or her TPU, and computed it as the inverse of the selection probability of a future teacher in a TPU.

4 For structural reasons, the future teachers were selected from within the (only) session group and the future teacher base weight was calculated per session group. However, because future teacher sampling was only possible in cases where just one session group was created per TPU, the actual wording of the text is appropriate.

In institutions where session group sampling was performed, all future teachers within a selected session group were automatically selected for the survey. In these instances, the future teacher base weight was set as 1.

For each selected future teacher $t = 1, \ldots, f_{hild}$ in each session group $d = 1, \ldots, s_{hil}$ of TPU $l = 1, \ldots, Q_{hi}$ from institution $i = 1, \ldots, n_h$ in explicit stratum $h = 1, \ldots, H$, the future teacher base weight was given as

$$WGTFAC3_{hildt} = \begin{cases} \dfrac{F_{hild}}{f_{hild}}, & \text{for TPUs with individual future teacher sampling} \\ 1 & \text{for TPUs with no individual future teacher sampling.} \end{cases}$$

Given the two populations of interest (future teachers of primary and future teachers of lower-secondary schools), the future teacher base weight was calculated separately for both target populations. This approach is reflected in the population identifier attached to the future teacher base weight in each of the two files in the international database (WGTFAC3**P** and WGTFAC3**S**).

10.2.8 Future Teacher Nonresponse Adjustment Factor

Unfortunately, not all selected future teachers were able or willing to participate in TEDS-M. However, the future teachers who were represented by the nonparticipating future teachers still needed to be represented by the sample. This fact explains why the TEDS-M team needed to introduce a nonresponse adjustment factor. This adjustment was made within each TPU but across session groups.[5]

In each TPU $l = 1, \ldots, Q_{hi}$, in each participating institution $i = 1, \ldots, r_h$ of each explicit stratum $h = 1, \ldots, H$, if the number of participating future teachers was noted as v_{hi}, then the future teachers nonresponse adjustment factor was given as

$$WGTADJ3_{hilt} = \begin{cases} \dfrac{f_{hil}}{v_{hil}}, & \text{for participating future teachers} \\ 0, & \text{for nonparticipating future teachers.} \end{cases}$$

Again, the two populations of interest (future teachers of primary and of lower-secondary students) meant the need to calculate the future teacher nonresponse adjustment factor separately for each target population. This requirement is reflected in the population identifier attached to the future teacher nonresponse adjustment factor in each of the two files in the international database (WGTADJ3**P** and WGTADJ3**S**).

5 In extremely rare cases, the following situation arose. A selected institution was found to be offering two or more TPUs accommodating the same level of future teacher training (primary or lower secondary). An example is a university that was offering a program producing Bachelor of Primary Education degrees and another program preparing mathematics specialists (also eventually able to teach primary students). Nobody in the second program responded, but the institution still counted as participating because the overall participation rate of future primary teachers was equal to or above 50 percent. Consequently, the nonresponse adjustment for the latter TPU could not be calculated according to the standard procedure since there were no respondents in this TPU who could carry the weight of the nonrespondents. In this instance, the nonresponse adjustment for future teachers in this TPU was done across institutions, but within explicit strata and within the route × level combination.

10.2.9 Future Teacher Level Weight

In some participating countries, future teachers were being certified to teach primary and lower-secondary students. These future teachers were therefore eligible for inclusion in both target populations of the TEDS-M future teacher survey. However, it would have been very difficult to convince those future teachers to participate in both surveys; that is, to complete both a primary and a lower-secondary questionnaire. Thus, in practice, TEDS-M randomly assigned those future teachers to one of the two surveys. The future teacher level weight adjusted for this procedure.

In each TPU $l = 1, \ldots, Q_{hi}$ in each participating institution $i = 1, \ldots, r_h$ of each explicit stratum $h = 1, \ldots, H$, if the number of selected future teachers eligible for both target populations but assigned to the primary future teacher survey was noted by f_{hil_prim}, and if the number of all selected future teachers in this TPU was noted by f_{hil}, then the future teacher level weight (primary) was given as

$$WGTFAC4P_{hilt} = \begin{cases} \dfrac{f_{hil}}{f_{hil\_prim}}, & \text{for TPUs with future teachers who were eligible for primary and secondary teaching} \\ 1, & \text{for TPUs with future teachers who were eligible for primary teaching only.} \end{cases}$$

Respectively, in each TPU $l = 1, \ldots, Q_{hi}$, in each participating institution $i = 1, \ldots, r_h$ of each explicit stratum $h = 1, \ldots, H$, if the number of selected future teachers who were eligible for both target populations but were assigned to the lower-secondary future teacher survey was noted by f_{hil_sec}, and if the number of all selected future teachers in this TPU was noted by f_{hil}, then the future teacher level weight (lower secondary) was given as

$$WGTFAC4S_{hilt} = \begin{cases} \dfrac{f_{hil}}{f_{hil\_sec}}, & \text{for TPUs with future teachers who were eligible for primary and secondary teaching} \\ 1, & \text{for TPUs with future teachers who were eligible for secondary teaching only.} \end{cases}$$

10.2.10 Final Future Teacher Weight

The final future teacher weight (estimation weight) was the product of the final institution weight, the session group base weight, the future teacher base weight, the future teacher nonresponse adjustment factor, and the future teacher level weight, calculated for the respective future teacher population (INSWGT**P** or INSWGT**S**). All estimates pertaining to the populations of future teachers should use the final future teacher weight.

For each participating future primary teacher $t = 1, \ldots, f_{hild}$, in each session group $d = 1, \ldots, s_{hil}$, in each TPU $l = 1, \ldots, Q_{hi}$, in each participating institution $i = 1, \ldots, r_h$, in explicit stratum $h = 1, \ldots, H$, the final future teacher weight was given as

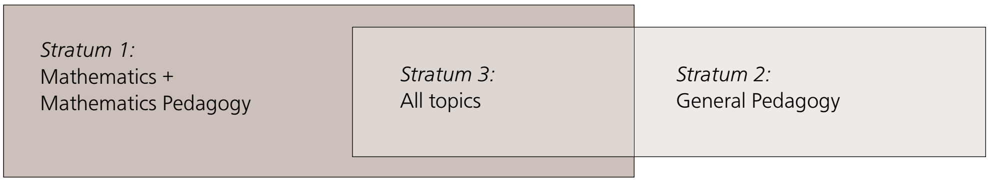
$$FINWGTP_{hildt} = INSWGTP_{hi} \times WGTFAC2P_{hild} \times WGTFAC3P_{hildt} \times WGTADJ3P_{hilt} \times WGTFAC4P_{hilt}$$
$$= \left(\frac{F_h}{n_h \times F_{hi}}\right) \times \left(\frac{S_{hil}}{s_{hil}}\right) \times \left(\frac{F_{hild}}{f_{hild}}\right) \times \left(\frac{f_{hil}}{v_{hil}}\right) \times \left(\frac{f_{hil}}{f_{hil\_prim}}\right).$$

For each participating future lower-secondary teacher $t=1, ..., f_{hild}$, in each session group $d=1, ..., s_{hil}$, in each TPU $l=1, ..., Q_{hi}$, in each participating institution $i=1, \ldots, r_h$, in explicit stratum $h=1, \ldots, H$, the final future teacher weight was given as

$$FINWGTS_{hildt} = INSWGTS_{hi} \times WGTFAC2S_{hild} \times WGTFAC3S_{hildt} \times WGTADJ3S_{hilt} \times WGTFAC4S_{hilt}$$
$$= \left(\frac{F_h}{r_h \times F_{hi}}\right) \times \left(\frac{S_{hil}}{s_{hil}}\right) \times \left(\frac{F_{hild}}{f_{hild}}\right) \times \left(\frac{f_{hil}}{v_{hil}}\right) \times \left(\frac{f_{hil}}{f_{hil\_sec}}\right).$$

10.2.11 Educator Base Weight

In each participating institution, up to three strata of educators could be created: mathematics and mathematics-pedagogy educators, general-pedagogy educators, and those educators teaching all topics.



TEDS-M required samples of 30 educators for each of the two groups of educators (mathematics and mathematics pedagogy, and general pedagogy). All educators were asked to complete specific parts of the educator questionnaire. While educators belonging to Stratums 1 and 2 had to complete only those parts that concerned their specific teaching responsibilities, educators belonging to Stratum 3 were asked to complete the whole questionnaire.

For educators, the TEDS-M team selected systematic random samples with equal probabilities from each stratum. The team then used the educator base weight (or design weight) to bring the individual educator's information to the level of his or her institution. In most cases, all TEDS-M-eligible educators in an institution were selected.

For each selected educator $j=1, ..., e_{hig}$ of stratum (or educator-group) $g=1, \ldots, G$ from institution $i=1, ..., n_h$ in explicit stratum $h=1, ..., H$, the educator base weight was given as[6]

$$WGTFAC2E_{higj} = \begin{cases} \dfrac{E_{hig}}{e_{hig}}, & \text{for random samples of educators} \\ 1, & \text{for censuses of educators.} \end{cases}$$

10.2.12 Educator Nonresponse Adjustment Factor

Not all selected educators were able or willing to participate in TEDS-M. However, the educators who were represented by the nonparticipating educators still needed to be represented by the sample, which is why the TEDS-M team needed to introduce a nonresponse adjustment factor.

6 In extremely rare instances (several institutions in Poland and Switzerland), educators had multiple probability of being selected because they were teaching in more than one institution. In these instances, the educator base weight was divided by the number of institutions where the affected educators were teaching.

In each of stratum $g = 1, \ldots, G$ of each participating institution $i = 1, \ldots, r_h$ of each explicit stratum $h = 1, \ldots, H$, if the number of participating educators was noted as p_{hig}, the educator nonresponse adjustment factor was given as

$$WGTADJ2E_{higj} = \begin{cases} \dfrac{e_{hig}}{p_{hig}}, & \text{for participating educators} \\ 0, & \text{for nonparticipating educators.} \end{cases}$$

In some cases, none of the selected educators in an educator-group within an institution responded. Consequently, it was not possible to calculate the nonresponse adjustment using standard procedures because there were no respondents who could carry the weight of the nonrespondents. In these situations, the TEDS-M team carried out the nonresponse adjustment for educators in this educator-group in the affected institution across institutions, but still within explicit strata and within the educator-group.

10.2.13 Final Educator Weight

The final educator weight (estimation weight) was the product of the educator base weight, the educator nonresponse adjustment factor, and the final institution weight calculated for the educator population (INSWGTE). The final educator weight should be used for all estimates pertaining to the populations of educators.

For each participating educator $j = 1, \ldots, p_{hig}$, in each participating institution $i = 1, \ldots, r_h$, in explicit stratum $h = 1, \ldots, H$, the final educator weight was given as

$$\begin{aligned} FINWGTE_{higj} &= INSWGTE_{hi} \times WGTFAC2E_{higj} \times WGTADJ2E_{higj} \\ &= \left(\frac{F_h}{r_h \times F_{hi}}\right) \times \left(\frac{E_{hig}}{e_{hig}}\right) \times \left(\frac{e_{hig}}{p_{hig}}\right) \\ &= \left(\frac{F_h}{r_h \times F_{hi}}\right) \times \left(\frac{E_{hig}}{p_{hig}}\right). \end{aligned}$$

10.3 Participation Rates

The TEDS-M quality standards required minimum participation rates for all target populations of the survey in order to produce statistics purporting to describe characteristics of those populations. The aim of these standards was to ensure that bias resulting from nonresponse was kept within acceptable limits.

In TEDS-M, the participation rates for each country were calculated and reported separately for the four different TEDS-M target populations. Reports describing the results for each target population thus consider the participation rate for that target population only. In short, the minimum requirement under which TEDS-M can publish key statistical data for international comparisons for each population is either that

- The overall (combined) participation rate (weighted or unweighted) of that population is at least 75 percent;

  or

- The participation rate (weighted or unweighted) of institutions for the considered population *and* the participation rate for individuals within the participating institutions are both at least 85 percent.

The intention in this section of the chapter is to explain in detail the calculation procedures for the different participation rates.[7] All participation rates were calculated not only as unweighted but also as weighted to reflect the structure of the sample in each rate. However, in many cases, the weighted participation rates deviated little (if at all) from the unweighted rate. TEDS-M deemed the participation rate requirements to have been met if either the weighted or the unweighted participation rate was sufficient.

10.3.1 Participation Rates for Institutions

Before the international and national TEDS-M teams could publish statistical summaries about institutions (or rather their programs) in a given country, they first had to establish if the number of institutional program questionnaires (IPQs) returned was sufficient to provide a useful sample of institutions in that country. TEDS-M set the return criterion as at least 85 percent of the sampled institutions in a country returning questionnaires. An institution was considered to be a participating one if it returned at least one IPQ.

If r out of n selected institutions were participating institutions, the unweighted institutional participation rate (IPR_I) was given as

$$IPR_I = \frac{\sum_{h=1}^{H} r_h}{\sum_{h=1}^{H} n_h}$$

and the weighted institutional participation rate ($IPR_{I\text{-}wgt}$) as

$$IPR_{I-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h} WGTFAC1I_{hi}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h} WGTFAC1I_{hi} \times WGTADJ1I_{hi}}.$$

10.3.2 Participation Rates for Future Primary Teachers

TEDS-M stipulated that statistical summaries pertaining to future primary teachers in a given country could only be published if returns of the primary-level future teacher questionnaire (FTQ) were sufficient to provide a useful sample of future primary teachers in that country. TEDS-M therefore had to set the criterion for an acceptable response rate.

TEDS-M accordingly counted an institution as "having participated" in the future primary teacher survey if the response rate for future primary teachers within the institution was at least 50 percent.[8] Then, if 85 percent or more of the sampled institutions in the country participated, and if, within those participating institutions, completed FTQs were received from 85 percent or more of the sampled future primary teachers, TEDS-M considered the criterion to have been met.

7 Some illustrative examples can be found in Annex 1 of the TEDS-M sample preparation manual (IEA, 2007a).

8 TEDS-M accepted data from institutions if only one additional future teacher respondent would have brought the response rate in that institution to over the 50 percent threshold.

Formally, the unweighted institutional participation rates for future primary teachers (IPR_P) were computed as

$$IPR_P = \frac{\sum_{h=1}^{H} r_h}{\sum_{h=1}^{H} n_h}$$

with r institutions participating in the survey of future primary teachers out of n selected. The weighted institutional participation rate for future primary teachers ($IPR_{P\text{-}wgt}$) was computed as

$$IPR_{P-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1P_{hi} \times WGTFAC2P_{hild} \times WGTFAC3P_{hildt} \times WGTADJ3P_{hilt} \times WGTFAC4P_{hilt}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1P_{hi} \times WGTADJ1P_{hi} \times WGTFAC2P_{hild} \times WGTFAC3P_{hildt} \times WGTADJ3P_{hilt} \times WGTFAC4P_{hilt}}$$

The unweighted participation rate for future primary teachers (WPR_P) with v participating future primary teachers out of f selected future primary teachers[9] across all participating institutions was calculated as

$$WPR_P = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h} v_{hi}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h} f_{hi}}$$

and the weighted participation rate for future primary teachers ($WPRP_{wgt}$) as

$$WPR_{P-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1P_{hi} \times WGTFAC2P_{hild} \times WGTFAC3P_{hildt} \times WGTFAC4P_{hilt}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1P_{hi} \times WGTFAC2P_{hild} \times WGTFAC3P_{hildt} \times WGTADJ3P_{hilt} \times WGTFAC4P_{hilt}}$$

TEDS-M considered the criterion to have been met if

($IPR_P \geq 0.85$ and $WPR_P \geq 0.85$) or ($IPR_{P\text{-}wgt} \geq 0.85$ and $WPR_{P\text{-}wgt} \geq 0.85$).

If one of the two participation rates IPR_P or WPR_P (or their weighted equivalents) fell short of the 85 percent criterion, TEDS-M deemed the criterion to have been met if the product of these two rates was 75 percent or higher; that is, if the combined participation rate was

($CPR_P = IPR_P \times WPR_P \geq 0.75$) or ($CPR_{P\text{-}wgt} = IPR_{P\text{-}wgt} \times WPR_{P\text{-}wgt} \geq 0.75$).

9 Note that future teachers indicated as being on longterm leave (e.g., maternity or sabbatical) were removed from the number of selected future teachers' f before calculation of the participation rate because they were deemed to be out of scope (i.e., not in their final year).

In effect, the second criterion required that FTQs be received from at least 75 percent of the sampled future primary teachers. Future teachers whose courses qualified them to teach both primary and lower-secondary students were taken into the count for both levels.

10.3.3 Participation Rates for Future Lower-Secondary Teachers

Before the TEDS-M teams could publish statistical summaries about future lower-secondary teachers in a given country, they first had to establish that the returns of the lower-secondary future teacher questionnaire (FTQ) were sufficient to provide a useful sample of future lower-secondary teachers in that country. The process for determining whether this criterion had been met was identical to that used for the future primary teacher samples. Hence, TEDS-M counted institutions as "having participated" in this part of the survey if at least 50 percent of the future lower-secondary teachers in that institution responded to the FTQ.[10]

Formally, the unweighted institutional participation rates for future lower-secondary teachers (IPR_S) was calculated as

$$IPR_S = \frac{\sum_{h=1}^{H} r_h}{\sum_{h=1}^{H} n_h}$$

with r institutions participating in the survey of future lower-secondary teachers out of n selected. The weighted institutional participation rate for future lower-secondary teachers (IPR_{S-wgt}) was computed as

$$IPR_{S-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1S_{hi} \times WGTFAC2S_{hild} \times WGTFAC3S_{hildt} \times WGTADJ3S_{hilt} \times WGTFAC4S_{hilt}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1S_{hi} \times WGTADJ1S_{hi} \times WGTFAC2S_{hild} \times WGTFAC3S_{hildt} \times WGTADJ3S_{hilt} \times WGTFAC4S_{hilt}} .$$

The unweighted participation rate for future lower-secondary teachers (WPR_S) with v participating future lower-secondary teachers out of f selected future lower-secondary teachers[11] across all participating institution was calculated as

$$WPR_S = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h} v_{hi}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h} f_{hi}}$$

10 Data from institutions were accepted if only one additional future teacher respondent would have brought the response rate in that institution to over the 50 percent threshold.

11 As was the case with the future primary teachers, the secondary future teachers indicated as being on longterm leave (e.g., maternity or sabbatical) were removed from the number of selected future teachers' f before calculation of the participation rate because they were deemed to be out of scope (i.e., not in their final year).

and the weighted participation rate for future lower-secondary teachers (WPR_{S-wgt}) as

$$WPR_{S-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1S_{hi} \times WGTFAC2S_{hild} \times WGTFAC3S_{hildt} \times WGTFAC4S_{hilt}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{l=1}^{Q_{hi}}\sum_{d=1}^{s_{hil}}\sum_{t=1}^{f_{hild}} WGTFAC1S_{hi} \times WGTFAC2S_{hild} \times WGTFAC3S_{hildt} \times WGTADJ3S_{hilt} \times WGTFAC4S_{hilt}} .$$

TEDS-M deemed the criterion to have been met if

($IPR_S \geq 0.85$ and $WPR_S \geq 0.85$) or ($IPR_{S\text{-}wgt} \geq 0.85$ and $WPR_{S\text{-}wgt} \geq 0.85$).

If one of the two participation rates (IPR_S or WPR_S, or their weighted equivalents) fell short of the 85 percent criterion, TEDS-M considered the criterion to have been met if the product of these two rates was 75 percent or higher; that is, if the combined participation rate was

($CPR_S = IPR_S \times WPR_S \geq 0.75$) or ($CPR_{S\text{-}wgt} = IPR_{S\text{-}wgt} \times WPR_{S\text{-}wgt} \geq 0.75$).

In effect, the second criterion required receipt of FTQs from at least 75 percent of the sampled future lower-secondary teachers. Future teachers whose courses qualified them to teach both primary and lower-secondary students were counted as respondents at both survey levels.

10.3.4 Participation Rates for Educators

The process for determining whether the participation criterion had been met for the educator samples was identical to that used for the primary and lower-secondary future teacher samples. Hence, TEDS-M counted institutions as "having participated" in this part of the survey if at least 50 percent of the educators in the institution responded to the educator questionnaire.

Formally, the unweighted institutional participation rates for educators (IPR_E) were computed as

$$IPR_E = \frac{\sum_{h=1}^{H} r_h}{\sum_{h=1}^{H} n_h}$$

with r institutions participating in the survey of educators out of n selected and the respective weighted institutional participation rate for educators (IPR_{E-wgt}) calculated as

$$IPR_{E-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{g=1}^{G}\sum_{j=1}^{P_{hig}} WGTFAC1E_{hi} \times WGTFAC2E_{higj} \times WGTADJ2E_{higj}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{g=1}^{G}\sum_{j=1}^{P_{hig}} WGTFAC1E_{hi} \times WGTADJ1E_{hi} \times WGTFAC2E_{higj} \times WGTADJ2E_{higj}} .$$

The unweighted participation rate for educators (WPR_E) with *p* participating educators out of *e* selected educators across all participating institutions was calculated as

$$WPR_E = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h} P_{hi}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h} e_{hi}}$$

and the weighted participation rate for educators ($WPR_{E\text{-}wgt}$) as

$$WPR_{E-wgt} = \frac{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{g=1}^{G}\sum_{j=1}^{P_{hig}} WGTFAC1E_{hi} \times WGTFAC2E_{higj}}{\sum_{h=1}^{H}\sum_{i=1}^{r_h}\sum_{g=1}^{G}\sum_{j=1}^{P_{hig}} WGTFAC1E_{hi} \times WGTFAC2E_{higj} \times WGTADJ2E_{higj}} \,.$$

TEDS-M deemed the criterion to have been met if

$(IPR_E \geq 0.85$ and $WPR_E \geq 0.85)$ or $(IPR_{E-wgt} \geq 0.85$ and $WPR_{E-wgt} \geq 0.85)$.

If one of the two participation rates (IPR_E or WPR_E, or their weighted equivalents) fell short of the 85 percent criterion, TEDS-M considered the criterion to have still been met if the product of these two rates was 75 percent or higher; that is, if the combined participation rate was

$(CPR_E = IPR_E \times WPR_E \geq 0.75)$ or $(CPR_{E-wgt} = IPR_{E-wgt} \times WPR_{E-wgt} \geq 0.75)$.

In effect, the second criterion required receipt of FTQs from at least 75 percent of the sampled educators.

10.3.5 Sampling Adjudication Outcomes

Adjudication of the data was done separately for each participating country and each of the four TEDS-M survey populations, in accordance with the recommendations of the sampling referees[12] and in agreement with all further participants of the sampling adjudication meetings.[13] The full adjudication report included information on the following aspects:

- Targeted and surveyed populations (size, coverage, exclusions);
- Sampling, sample sizes, and participation rates (unweighted, weighted);
- Population count estimates;
- Relevant additional information;
- Notes on survey operations and data processing; and
- Adjudication comments.

If a country did not meet the required participation rates for one (or more) of the populations, the TEDS-M teams still reported statistics for that country. However, the authors of the international report (Tatto et al., 2012) provided in it annotations pointing out countries that had failed the requirements. These annotations signaled the reduced reliability of the data for those countries.

12 Jean Dumais and Marc Joncas, Statistics Canada.

13 Maria Teresa Tatto, John Schwille, and Sharon Senk, as representatives of the international study center; Sabine Meinck as the representative of the IEA DPC sampling team.

The following adjudication comments were observed by those members of the TEDS-M team responsible for reporting TEDS-M data. The comments apply to each of the sampled populations.

1. *Reporting without any annotation:* No annotation was made if a country met all participation rate requirements for the population in scope, had an exclusion rate of below five, and had full coverage of the target population.
2. *Annotation because of low participation rates:* This comment was designated for when a country's participation rate for the population in scope was below the requirement but the combined participation rate was still above 60 percent.[14]
3. *Participation rates clearly below standards; reporting together with other countries not advisable:* This comment applied to instances of the combined participation rate for a population dropping below 60 percent but still being above 30 percent.
4. *Unacceptable (move to appendix):* This comment applied if the combined participation rate for a population dropped below 30 percent.

Exhibit 10.2 provides a summary of the adjudication outcomes.

Exhibit 10.3 displays the achieved unweighted participation rates. The weighted participation rate is reported instead of the unweighted participation rate in cases where the weighted participation rate affected the data adjudication. Respective occasions are marked as such. Exhibits 10.4 to 10.7 show the expected versus the achieved sample sizes for each population.

10.4 Estimating Sampling Error with Balanced Repeated Replication (BRR)

10.4.1 Reasons for Using BRR

As described in Chapter 7 on survey design, surveys with complex designs such as TEDS-M require special attention with regard to estimation, especially estimation of the sampling error. Both the survey design and the unequal weights need to be taken into account to obtain (approximately) unbiased estimates of sampling error. Failure to do so can lead to severe underestimation of the sampling error. While exact formulae exist in theory for stratified probability proportional to size (PPS) sample designs, the required computations become practically impossible to do as soon as the number of primary units selected per stratum exceeds two.

Researchers and analysts have proposed approximate solutions to cases such as these over the years. An important class of solutions is that of *resampling or replication. Interpenetrating sub-samples* (Mahalanobis), *balanced half-samples* or *balanced repeated replication* (McCarthy, Fay), the *jackknife* (Quenouille, Tukey, Durbin, Frankel), and the *bootstrap* (Efron) are the best-known examples of replication methods (for a review of these methods, see, for example, Lohr, 1999; Rust & Rao, 1996; Wolter, 2007). TEDS-M adopted the balanced repeated replication (BRR) (McCarthy, 1966) for estimation of the sampling error of the estimates produced for the study.

14 Annotations were also advised if the exclusion rate exceeded five percent or if reduced coverage of the target population was observed.

Exhibit 10.2: Summary of adjudication results

Countries	Institutions	Teacher Educators	Future Primary Teachers	Future Lower-Secondary Teachers
Botswana	None	None	None	None
Canada (four provinces)	Unacceptably low participation rates. The data remain unweighted and are not reported	Unacceptably low participation rates. The data remain unweighted and are not reported	Unacceptably low participation rates. The data remain unweighted and are not reported	Unacceptably low participation rates. The data remain unweighted and are not reported
Chile	None	Low participation rates; data are highlighted to make readers aware of increased likelihood of bias.	Combined participation rate between 60 75 percent.	Combined participation rate between 60 75 percent.
Chinese Taipei	Exclusion rate > 5% (very small institutions were excluded).	None	None	None
Georgia	None	None	None	Combined participation rate between 60 and 75%. An exception was made to accept data from two institutions because, in each case, one additional participant would have brought the response rate to above the 50% threshold.
Germany	None	Low participation rates; data are highlighted to make apparent the increased likelihood of bias. Surveys of institutions and teachers were not connected with survey of educators.	None	None
Malaysia	Low participation rates; data are highlighted to make apparent the increased likelihood of bias.	Low participation rates; data are highlighted to make apparent the increased likelihood of bias.	None	None
Norway	None	Participation rates could not be calculated; data remain unweighted and are not reported.	Combined participation rate between 60 and 75%. An exception was made to accept data because one additional participant would have brought the response rate to above the 50% threshold. Program-types "ALU" and "ALU plus mathematics" are partly overlapping populations; analysis across program-types is inappropriate because of this overlap.	Low participation rates; data are highlighted to make apparent the increased likelihood of bias. Program-types "ALU" and "ALU plus mathematics" are partly overlapping populations; results derived from analysis across program-types should be conducted with care to avoid undue overlap of populations.

Exhibit 10.2: Summary of adjudication results (contd.)

Countries	Institutions	Teacher Educators	Future Primary Teachers	Future Lower-Secondary Teachers
Oman	Provided education for future secondary teachers only at the time of testing.	Provided education for future secondary teachers only at the time of testing.	Not applicable	None
Philippines	Exclusion rate > 5% (very small institutions were excluded).	None	None	None
Poland	Institutions with consecutive programs only were not covered.	Combined participation rate between 60 and 75%; institutions with consecutive programs only were not covered.	Combined participation rate between 60 and 75%; institutions with consecutive programs only were not covered.	Combined participation rate between 60 and 75%; institutions with consecutive programs only were not covered.
Russian Federation	Secondary pedagogical institutions were not covered.	Secondary pedagogical institutions were not covered.	Secondary pedagogical institutions were not covered.	An unknown percentage of surveyed future teachers were already certificated primary teachers.
Singapore	None	None	None	None
Spain (primary education only)	None	None	None	Not applicable
Switzerland (German-speaking parts only)	None	Low participation rates; data are highlighted to make apparent the increased likelihood of bias.	None	None
Thailand	None	None	None	None
United States (public institutions)	None	Unacceptably low participation rates; data remain unweighted and are not reported here.	An exception was made to accept data from two institutions because, in each case, one additional participant would have brought the response rate to above the 50% threshold. Items with low responses are clearly marked.	Combined participation rate between 60 and 75% only. An exception was made to accept data from one institution because rate within it was below 50%. This brought the response rate to above the 50% threshold.

Exhibit 10.3: Unweighted participation rates for institutions, future primary and lower-secondary teachers, and teacher educators

Country	Institutions (Composition of IPQs)	Future Primary Teachers			Future Lower-Secondary Teachers			Educators		
	IPR_I (%)	$IPRI_P$ (%)	WPR_P (%)	CPR_P (%)	$IPRI_S$ (%)	WPR_S (%)	CPR_S (%)	IPR_E (%)	WPR_E (%)	CPR_E (%)
Botswana	100	100	86	86	100	88	88	100	98	98
Canada (four Provinces)	37	7	69	5	29	72	21	33	79	26
Chile	88	86	79	68	83	76	63	70	77	54
Chinese Taipei	100	100	90	90	100	97	97	100	95	95
Georgia	100	100	77	77	100	67	67	100	97	97
Germany	100	93	82	76	100	81	81	92	61	56
Malaysia	57	96	97	93	86	84	72	73	77	57
Norway	96	88	86	75	78	80	63	Data not processed		
Oman	100	Not applicable			100	93	93	100	85	85
Philippines	85	80	91	75[a]	91	92	83	85	94	80
Poland	86	86	79	68	82	84	69	79	86	68
Russian Federation	91	96	94	91	98	94	92	98	92	91
Singapore	100	100	90	90	100	91	91	100	85	85
Spain (primary education only)	96	90	87	78	Not applicable			92	93	85
Switzerland (German-speaking parts only)	94	100	76	76	100	81	81	75	69	52
Thailand	96	98	99	97	98	98	96	93	94	88
United States (public institutions only)	83	85	85*	71	82	84	69	23	58	14

Note: a Weighted participation rate.

Exhibit 10.4: Institutions: expected and achieved sample sizes

Country	Number of Institutions in Original Sample	Ineligible Institutions	Total Number of Institutions Providing Response to the IPQ	Number of Expected IPQs within Participating Institutions	Number of Returned IPQs within Participating Institutions
Botswana	7	0	7	7	7
Canada (four provinces)	30	0	11	32	23
Chile	50	10	35	42	38
Chinese Taipei	19	0	19	19	19
Georgia	10	0	10	17	17
Germany	16	0	16	51	51
Malaysia	34	4	17	33	20
Norway	23	0	22	22	22
Oman	7	0	7	8	8
Philippines	80	20	51	83	82
Poland	92	1	78	130	125
Russian Federation	58	1	52	98	88
Singapore	1	0	1	10	10
Spain (primary education only)	50	0	48	48	48
Switzerland (German-speaking parts only)	16	0	15	32	28
Thailand	46	0	44	53	51
United States (public institutions only)	60	0	50	136	117

Exhibit 10.5: Future primary teachers: expected and achieved sample sizes

Country	Number of Institutions in Original Sample	Ineligible Institutions	Total Number of Institutions that Participated	Number of Sampled Future Primary Teachers in Participating Institutions	Number of Participating Future Primary Teachers
Botswana	4	0	4	100	86
Canada (four provinces)	28	0	2	52	36
Chile	50	14	31	836	657
Chinese Taipei	11	0	11	1,023	923
Georgia	9	0	9	659	506
Germany	15	0	14	1,261	1,032
Malaysia	28	4	23	595	576
Norway	16	0	14	185	159
Oman	Not applicable				
Philippines	60	19	33	653	592
Poland	91	0	78	2,673	2,112
Russian Federation	52	1	49	2,403	2,266
Singapore	1	0	1	424	380
Spain (primary education only)	50	0	45	1,259	1,093
Switzerland (German-speaking parts only)	14	0	14	1,230	936
Thailand	46	0	45	666	660
United States (public institutions only)	60	0	51	1,807	1,501

Exhibit 10.6: Future lower-secondary teachers: expected and achieved sample sizes

Country	Number of Institutions in Original Sample	Ineligible Institutions	Total Number of Institutions that Participated	Number of Sampled Future Lower-Secondary Teachers in Participating Institutions	Number of Participating Future Lower-Secondary Teachers
Botswana	3	0	3	60	53
Canada (four provinces)	28	0	8	174	125
Chile	50	10	33	977	746
Chinese Taipei	21	2	19	375	365
Georgia	6	0	6	116	78
Germany	13	0	13	952	771
Malaysia	7	0	6	462	389
Norway	25	2	18	242	194
Oman	7	0	7	288	268
Philippines	60	7	48	800	733
Poland	28	0	23	355	298
Russian Federation	50	1	48	2,275	2,141
Singapore	1	0	1	431	393
Spain (primary education only)	Not applicable				
Switzerland (German-speaking parts only)	6	0	6	174	141
Thailand	46	0	45	667	652
United States (public institutions only)	59	3	46	726	607

Exhibit 10.7: Teacher educators: expected and achieved sample sizes

Country	Number of Institutions in Original Sample	Ineligible Institutions	Total Number of Institutions that Participated	Number of Sampled Teacher Educators in Participating Institutions	Number of Participating Teacher Educators
Botswana	7	0	7	44	43
Canada (four provinces)	30	0	10	94	74
Chile	50	10	28	510	392
Chinese Taipei	19	0	19	205	195
Georgia	10	0	10	64	62
Germany	50	0	46	792	482
Malaysia	34	4	22	330	255
Norway	Data not processed				
Oman	7	0	7	99	84
Philippines	80	20	51	626	589
Poland	92	1	72	857	734
Russian Federation	58	1	56	1,311	1,212
Singapore	1	0	1	91	77
Spain (primary education only)	50	0	46	574	533
Switzerland (German-speaking parts only)	16	0	12	318	220
Thailand	46	0	43	331	312
United States (public institutions only)	60	0	14	407	241

BRR is a replication method suited to sample designs where exactly two primary sampling units (PSUs) are selected in each stratum. The principle underpinning BRR is the following: each of the two PSUs can provide an unbiased estimate of the total (or other parameter of interest) of its stratum. If the sampling design comprises H strata, 2^H possible unbiased estimates of the parameter of interest can be obtained by combining either PSU from each of the H strata. The sampling error of the estimate of the parameter of interest can be directly computed by comparing each of the 2^H estimates with their mean, as one usually does in simple basic statistics. Even with moderate values of H, the number of unbiased estimates may be quite large (e.g., $2^5 = 32$, $2^{10} = 1\,024$, $2^{20} = 1\,048\,576$,…). BRR provides a way of extracting from the complete set of 2^H possible replicates a much smaller subset that gives the very same measure of sampling error as would the full set.

10.4.2 Creating Replicates for BRR

BRR for the sample designs was developed using only two PSUs per stratum. Although none of the countries participating in TEDS-M had implemented such a sample design, it was fortunately possible to approximate the implemented sample design by using a superimposed "BRR-ready" sample plan. Listing the institutions in the order in which they appeared on the sampling frame allowed pairing of the participating institutions (of the original sample or the replacements) within explicit strata. Each pair was dubbed a "pseudo stratum" or "zone." If the number of participating institutions in an explicit stratum was odd, a triplet was formed with the last three institutions. The pairs (or triplets) were then numbered sequentially from 1 to G, spanning the whole sample, and each institution within a pseudo stratum or zone was assigned a random pseudo PSU number 1 or 2 (or 3 for a triplet) as depicted in Exhibit 10.8.

Exhibit 10.8: Example of "BRR-ready" sample design and random assignation of pseudo PSUs

Explicit Stratum	Institution ID	Zone = Pseudo Stratum	Pseudo PSU	Any Variables of Interest	
1	1010	1	1	…	…
1	1020	1	2		
1	1030	2	1		
1	1040	2	2		
2	1050	3	2		
2	1060	3	1		
2	1070	4	1		
2	1080	4	2		
2	1090	4	3		
3	1100	5	1	…	…
H	…	*G-1*	2		
H	…	*G-1*	1		
H	…	*G*	1		
H	…	*G*	2		

As occurs with the jackknife repeated replication, one of the two pseudo PSUs is dropped and the remaining PSU is used to compute an estimate of the parameter of interest. The randomization of the PSUs is, however, somewhat different. First, a label, +1 or -1, is assigned at random to one of the pseudo PSUs of a zone; the second pseudo PSU is automatically assigned to the remaining label. A special matrix (of order $4t$, $t = 1, 2, \ldots$) of +1's and -1's then indicates which PSU is to be kept from each pseudo stratum. For example, the Hadamard matrix of order 8 can be given by

$$Hadamard_8 \begin{pmatrix} +1 & +1 & +1 & -1 & +1 & -1 & -1 & -1 \\ -1 & +1 & +1 & +1 & -1 & +1 & -1 & -1 \\ -1 & -1 & +1 & +1 & +1 & -1 & +1 & -1 \\ +1 & -1 & -1 & +1 & +1 & +1 & -1 & -1 \\ -1 & +1 & -1 & -1 & +1 & +1 & +1 & -1 \\ +1 & -1 & +1 & -1 & -1 & +1 & +1 & -1 \\ +1 & +1 & -1 & -1 & -1 & -1 & +1 & -1 \\ -1 & -1 & -1 & -1 & -1 & -1 & -1 & -1 \end{pmatrix}$$

If H is a Hadamard matrix of order $4t$, then $H'H = 4tI$. The orthogonality of the matrix is the basis for "balanced" in BRR. TEDS-M used a Hadamard matrix of order 32, which led to 32 replicates.

Because the standard BRR method can become unstable when applied to sparse samples, TEDS-M applied Fay's modification to overcome this shortage (Fay, 1989; see also Judkins, 1990). The idea behind Fay's modification is not to completely drop one of the PSUs and double the other but rather to always use some linear combination of the two pseudo PSUs comprising a zone. For TEDS-M, with respect to pairs, the weight of one PSU was multiplied by 1.5 and the weight of the corresponding PSU by 0.5. With triplets, the factors were 1.7071 for a given replicate and 0.6464 for the other two replicates, or 0.2929 for one and 1.3536 for the other two.

Each of the four TEDS-M data files (i.e., comprising data from the four different survey populations) contained two sets of BRR variables (pseudo stratum, pseudo PSU, 32 replicates). One set referred to the respective final institution weight (see Section 10.2.3 above). The pseudo strata referring to institutions was created firstly for samples of institutions as explained above (pairing adjacent institutions) and secondly for censuses by pairing similar institutions.[15] The second set of BRR variables referred to the respective final population weight (final TPU weight, final future teacher weight [primary/secondary], and final educator weight). With samples of institutions, adjacent institutions were again paired in order to build the BRR pseudo strata. If, however, all institutions in a country were asked to participate (or any institution had a selection probability of 1), TEDS-M implemented another approach, as follows:

- In the data files comprising data from the institutional program questionnaire, TPUs were paired, imposing the route × level combination as the explicit stratum. This step meant that only TPUs preparing future teachers in the same route × level combination were paired, but the pairing happened across institutions.
- In data files comprising future teacher data, the individual future teachers were paired, thereby imposing the institutions as explicit strata.

15 Similarity of institutions was defined as a function of the specific level × route combinations offered by the institutions. For more details, see Appendix C of this report, "Characteristics of National Samples."

- In data files comprising educator data, the individual educators were paired, thereby imposing the educator-groups within the institutions as explicit strata.

Again, in cases where the number of units to be paired within an explicit stratum was an odd number, triplets were built.

10.4.3 Estimating the Sampling Error

Let θ be the population parameter of interest. Let $\hat{\theta}$ be the full sample estimate for θ obtained by using the final weight and let $\hat{\theta}g$, $g = 1, \ldots, 32$, be the BRR replicate estimates of the same parameter of interest obtained by using the BRR weights described in Section 10.4.2. Then, setting $k = 0.5$, Fay's BRR estimate of the sampling variance of $\hat{\theta}$ is given as

$$\hat{V}_{FAY}(\hat{\theta}) = \frac{1}{G(1-k)^2} \sum_{g=1}^{G} (\hat{\theta}_g - \hat{\theta})^2 = 0.125 \sum_{g=1}^{32} (\hat{\theta}_g - \hat{\theta})^2$$

and the sampling error is (finally) the square root of the sampling variance.

10.4.4 Using Sampling Error when Comparing Estimates

When comparing estimates, either variables or groups within a country, across two countries, or a country value to the international average, one needs to scale this comparison by using the appropriate estimate of sampling error.

The standard error for the difference of two estimates from one country, say $\hat{\theta}_1$ and $\hat{\theta}_2$, is given as

$$se(\hat{\theta}_1 - \hat{\theta}_2) = \sqrt{\hat{V}_{FAY}(\hat{\theta}_1) + \hat{V}_{FAY}(\hat{\theta}_2) - 2\hat{Cov}_{FAY}(\hat{\theta}_1, \hat{\theta}_2)}$$
$$= \sqrt{\hat{V}_{FAY}(\hat{\varsigma})}$$

where $\hat{\varsigma} = \hat{\theta}_1 - \hat{\theta}_2$ is the difference between the two characteristics of interest (e.g., number of lessons in mathematics versus the number of lessons in pedagogy) measured within the participating institutions. When estimates of differences are required, it is often simpler to compute the difference for each record as a derived variable to compute the sampling error of the derived variable.

The standard error for the difference of the estimates for two countries, say $\hat{\theta}_c$ and $\hat{\theta}_d$, is given as

$$se(\hat{\theta}_c - \hat{\theta}_d) = \sqrt{\hat{V}_{FAY}(\hat{\theta}_c) + \hat{V}_{FAY}(\hat{\theta}_d)} \ .$$

The standard error for the difference of an estimate for a given country, say $\hat{\theta}_c$ and the international average $\hat{\hat{\theta}}$ is given as

$$se(\hat{\theta}_c - \hat{\hat{\theta}}) = \sqrt{\frac{(N^2 - 2N)\hat{V}_{FAY}(\hat{\theta}_c) + \sum_{k=1}^{N} \hat{V}_{FAY}(\hat{\theta}_k)}{N^2}}$$

where $\hat{\hat{\theta}} = \sum_{k=1}^{N} \hat{\theta}_k / N$, N being the number of countries contributing to the mean $\hat{\hat{\theta}}$, and $\hat{\theta}_c$ is the estimate for country "c".

If $\hat{\theta}$ is one of the statistics described above and $se(\hat{\theta})$ is the standard error of $\hat{\theta}$, then confidence intervals can easily be obtained by computing the following boundaries:

$$lower_{\alpha} = \hat{\theta} - t_{\frac{\alpha}{2};df}\, se(\hat{\theta}) \text{ and } upper_{\alpha} = \hat{\theta} + t_{\frac{\alpha}{2};df}\, se(\hat{\theta}),$$

where 1-α is the preset confidence level (e.g., 1-α = 0.95), and $t_{\frac{\alpha}{2};df}$ is 1-α/2 percentile of the student *t*-distribution with *df* degrees of freedom. In most applications, *df* will be large enough to allow the use of the standard normal deviate $z_{1-\alpha/2}$ (e.g., $z_{1-\alpha/2} = 1.96$ for $\alpha = 0.05$). Nevertheless, users should verify how many zones actually contribute to the statistic $\hat{\theta}$ and how many BRR replicates contribute to the computation of $se(\hat{\theta})$ in order to confirm the number of degrees of freedom.

10.4.5 Design Effect and Effective Sample Size

Complex surveys such as TEDS-M are known to be “less efficient” than simple random samples of the same size. Usual explanations for this lesser efficiency include the fact that respondents are selected in groups of individuals sharing many characteristics—school environment, professional training, classroom equipment, textbooks, and so on. The loss in efficiency is often summarized in a statistic called “design effect” or *deff* (Kish, 1965). The design effect (for a statistic and a sampling plan) is the ratio of the variance of the estimate under the sampling plan to the variance of the same estimate under simple random sampling of the same size. In the case of TEDS-M, the true design effect is approximated as

$$deff\,(\hat{\theta}, BRR) = \frac{\hat{V}_{BRR}(\hat{\theta})}{\hat{V}_{SRS}(\hat{\theta})}$$

Alternatively, the design effect can be regarded as the ratio of sample sizes, in which case the term “effective sample size” is used to describe the sample size of the complex survey adjusted for the design effect:

$$n_{effective} = \frac{n_{BRR}}{deff}\,.$$

Exhibits 10.9 and 10.10 present the estimated design effects for key TEDS-M variables by participating country for the two future teacher populations. The exhibits display not only the actual values for the design effects of the achievement variables *mathematics content knowledge* (MCK) and *mathematics pedagogy content knowledge* (MPCK) but also the average design effects over similar variables for the beliefs and opportunities to learn (OTL) scales.

As can be seen from the two exhibits, the design effect was often estimated as below 1 in countries where a stratified simple random sample design was applied (census of institutions) rather than a complex cluster design. In other words, the former designs—as could be expected—proved to be as efficient as (or, by trend, even slightly more efficient than) unstratified simple random samples. In countries with complex cluster samples in all strata (the Philippines, Russian Federation, and United States), it is clearly evident that the design effect is above 1. Extreme design effects can be observed for the Russian Federation for the two achievement scores. These effects resulted mainly from the large differences in the average achievement of future teachers within participating institutions, in addition to the applied sampling design with two clustering levels.

Exhibit 10.9: Future primary teachers: approximated design effects for key variables by participating country

Country	Design Effect for Achievement Scales (scaled around a mean of 500 *SD* 100)		Average Design Effect over Seven Belief Scales (Rasch scales, centered around 10 as neutral position)	Average Design Effect over 14 OTL Scales (Rasch scales, centered around 10 as neutral position)	Average Design Effect over 10 OTL Scales (sum scores with 6 as maximum)
	MCK	MPCK			
Botswana	1.30	1.15	1.13	0.84	0.82
Chile	0.71	1.10	0.79	0.97	0.92
Chinese Taipei	2.29	1.07	1.14	1.23	1.32
Georgia	1.03	1.23	0.80	0.97	0.96
Germany	1.04	1.93	2.15	1.71	1.52
Malaysia	0.66	1.20	1.08	0.76	1.03
Norway (program-type ALU) [a]	0.77	0.86	0.99	0.89	0.80
Norway (program-type ALU + mathematics) [a]	0.55	0.98	1.06	0.93	1.00
Philippines	12.93	12.40	6.48	6.02	7.57
Poland	1.04	0.65	1.30	1.39	1.18
Russian Federation	26.66	21.32	7.17	9.02	11.62
Singapore	0.68	0.88	0.87	0.97	0.88
Spain	2.36	1.37	2.76	4.49	3.11
Switzerland (German-speaking parts only)	0.79	0.62	0.83	0.96	0.93
Thailand	0.62	0.69	1.03	0.93	0.66
United States (public institutions only)	3.65	1.45	3.13	3.70	3.08

Note: a Program types "ALU" and "ALU + mathematics" are partly overlapping populations; the analysis was therefore separated by program-type.

Exhibit 10.10: Future lower-secondary teachers: approximated design effects for key variables by participating country

Country	Design Effect for Achievement Scales (scaled around a mean of 500, *SD* 100)		Average Design Effect over Seven Belief Scales (Rasch scales, centered around 10 as neutral position)	Average Design Effect over 14 OTL Scales (Rasch scales, centered around 10 as neutral position)	Average Design Effect over 10 OTL Scales (sum scores with 6 as maximum)
	MCK	MPCK			
Botswana	1.0	1.0	0.97	0.98	0.78
Chile	0.7	1.4	1.04	0.87	1.01
Chinese Taipei	1.0	1.1	1.02	0.86	0.94
Georgia	0.9	1.1	0.90	0.91	0.98
Germany	1.1	2.2	2.23	2.40	1.86
Malaysia	0.9	1.1	1.12	0.97	0.65
Norway (program-type ALU) [a]	1.0	1.2	1.04	0.78	0.93
Norway (program-type ALU + mathematics) [a]	0.8	1.1	1.11	1.00	1.07
Norway (program-type Master's) [a]	0.5	0.4	1.03	1.02	0.92
Norway (program-type PPU) [a]	0.9	1.5	0.97	0.96	1.01
Oman	0.7	0.9	0.96	0.99	1.04
Philippines	6.5	4.4	4.57	7.26	6.29
Poland	0.7	0.8	1.14	1.37	1.43
Russian Federation	37.8	23.8	5.21	9.18	9.77
Singapore	0.8	1.2	1.02	1.11	1.02
Switzerland (German-speaking parts only)	0.8	0.9	0.95	0.86	0.62
Thailand	0.5	1.0	0.91	0.99	0.93
United States (public institutions only)	9.3	5.9	5.33	3.56	5.99

Note: a Program-types "ALU", "ALU + mathematics" and "Master's" are partly overlapping populations; the analysis was therefore separated by program-type.

Exhibit 10.11 shows the average design effects for the beliefs and OTL scales of the educator population by participating country. Again, it can be seen that the design effects are clearly higher in the countries with complex cluster samples for this population (Germany, the Philippines, and the Russian Federation) than in countries with institution censuses. However, where the values are below 2, the design effects are still moderate. Considering that the scales were built identically from the future teacher and the educator questionnaires,[16] educators show conclusively lower clustering effects than future teachers, or, in other words, future teachers from one program tended to be more alike than were educators belonging to the same institution.

Exhibit 10.11: Educators: approximated design effects for key variables by participating country

Country	Average Design Effect over Six Belief Scales (Rasch scales, centered around 10 as neutral position)	Average Design Effect over 12 OTL Scales (Rasch scales, centered around 10 as neutral position)
Botswana	0.91	0.95
Chile	0.83	1.18
Chinese Taipei	3.42	1.40
Georgia	0.86	0.77
Germany	3.01	5.52
Malaysia	0.87	1.05
Oman	1.10	0.76
Philippines	3.80	2.57
Poland	1.07	1.04
Russian Federation	2.92	3.13
Singapore	0.91	0.88
Spain	1.29	1.06
Switzerland (German-speaking parts only)	0.96	0.98
Thailand	1.16	0.95

16 Major parts of the sections about OTL and beliefs were identical in the future teachers' and educators' questionnaires; most OTL and belief scales were built identically for both populations. For more information, see Chapter 4 of this technical report.

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CHAPTER 11:

SCALE DEVELOPMENT AND REPORTING: OPPORTUNITIES TO LEARN, BELIEFS, AND MATHEMATICS KNOWLEDGE FOR TEACHING

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11.1 Methods Used to Develop the Opportunity to Learn and Beliefs Scales: Overview

The TEDS-M opportunity to learn (OTL) and beliefs measures for future primary and lower-secondary teachers and their educators were based on scales and items developed in a variety of ways. Several scales and items built on previous research conducted at Michigan State University (MSU) and the Australian Council for Educational Research (ACER), and some were developed specifically for TEDS-M in general and the participating countries in particular.

After conducting an extensive pilot of a larger set of items, members of the TEDS-M international research team selected items that appeared to provide information on program, institution, and country variation. Items that survived initial exploratory factor analyses were used in the operational forms for the main study.

Drawing on a preconceived conceptualization of OTL in four broad categories (mathematics content, mathematics education pedagogy, general education pedagogy, and school-based experiences), the team used a confirmatory factor analysis process to assess the fit between each OTL scale measure and the data as well as the relationships among them. The OTL scales were then created in accordance with the best-fitting models. This process led to identification of several scales pertaining to each of the four broad categories. The total number of distinct OTL scales across all four categories was 24.

In order to form the OTL scales encompassing topics studied in relation to mathematics content, mathematics pedagogy, and general pedagogy, the TEDS-M team summed up the number of topics studied so that all of these scales could be interpreted in terms of the number of topics studied under each scale. For OTL scales based on items requiring the use of response-rating scales (e.g., activities in which future teachers participated from "never" to "often"), the team estimated Rasch logit scores and then centered them at the point on the relevant OTL scale associated with the middle of the rating scale (essentially "neutral"). More specifically, the test characteristic curve (essentially, the one-to-one correspondence table between summed score and Rasch measure) was used to identify the point on the Rasch scale associated with the midpoint on the summed score scale; this value was used to center the OTL scale at a scaled value of 10. All OTL scales based on Rasch logit scores could therefore be interpreted by comparing each such score with the scale midpoint (i.e., 10—the neutral position). The displays created for the OTL measurements can be found in the TEDS-M international report (Tatto et al., 2012).

The TEDS-M beliefs scales comprised items measuring beliefs about the nature of mathematics, learning mathematics, mathematics achievement, and preparedness for teaching mathematics. One other developed scale focused on the overall effectiveness of the teacher preparation program. As with development of the OTL scales, a confirmatory factor analysis process was used to assess the fit between each belief scale item and the data and, from there, create belief scale scores from the best-fitting models.

Again, as was done for the OTL items, item response theory (IRT) was used to scale each belief item. The scale was defined so that a score of 10 corresponded to a neutral response (i.e., equal propensity to agree or disagree with the statements presented). Scores above 10 indicated that responses predominantly agreed with the statements; scores below 10 indicated that responses predominantly disagreed with the statements. The TEDS-M team considered these scales, developed in order to obtain the best possible matching of the score to the underlying attribute, particularly suitable for quantifying the relationships among beliefs or between beliefs and other scores (e.g., the standardized scores for future teachers' mathematics content knowledge and future teachers' mathematics pedagogy content knowledge) on similarly constructed scales. The displays created for the beliefs measurements appear in the TEDS-M international report (Tatto et al., 2012).

Several OTL and belief scales were also created from the items used in the survey for the future teachers' educators. The item parameters calibrated from the future teachers' scores were used as fixed parameters to estimate the scale scores for educators, thus placing the OTL and beliefs scale scores from educators on the same scale as the future teachers' and thereby facilitating comparative inferences. The TEDS-M team obtained information about the fit between the OTL/beliefs measures and the educator responses by conducting confirmatory factor analyses using the MPlus software (Muthén & Muthén, 1998).

Reliabilities were unweighted and were estimated using jMetrik 2.1 software (Meyer, 2011). The reliability estimates were based on the congeneric measurement model, which allows each item to load on the common factor at different levels and allows item error variances to vary freely. (Each item can be measured with a different level of precision.) This measurement model is deemed the most flexible and appropriate one for measures with few items (see Appendices F, G, and H).

11.2 Development of the OTL Scales

Development of the OTL scales began at the very start of the TEDS-M project. This work drew on information obtained from previous research (Tatto, 1996, 1998, 1999). It also encompassed several existing scales, such as *connecting theories of teaching and learning* and *connecting practice and reflection*, developed and used successfully in research conducted at ACER prior to TEDS-M (Ingvarson, Beavis, Danielson, Ellis, & Elliott, 2005; Ingvarson, Beavis, & Kleinhenz, 2007). Information regarding the usefulness and effectiveness of this early work was gathered during development of the TEDS-M pilot study instruments. It provided strong validity-related evidence regarding the content of (i.e., the survey items making up) the OTL scales.

11.2.1 Analysis of the Pilot-Study Responses to the OTL Items

The TEDS-M research team conducted several levels of exploratory and confirmatory analyses on the pilot responses to all OTL items. The team also assessed the pilot findings against the TEDS-M conceptual framework (Tatto et al., 2008) and against prior research and evidence (see Chapter 4 of this report). Appendix I provides an account of the specific methods used during the pilot analyses of the OTL items.

The comprehensive analyses of the pilot results and the close accord between the OTL scale structures and findings from relevant prior research provided strong validity-related support for the construct definitions of OTL for future teachers. The national research coordinators (NRCs) of the participating countries also reviewed all OTL items before and after the pilot study.

11.2.2 Initial Analyses of the Main-Study Survey Results

Initial analyses to assess the quality of the items used in these surveys employed exploratory methods, including factor analysis, scale reliability analyses, and some limited Rasch scaling. Findings were remarkably similar to the pilot findings, and there was strong consistency between the future primary teacher and future lower-secondary teacher results. These early commonalities suggested successful identification of the items making up the OTL scales.

The TEDS-M team analyzed each of the OTL scales for psychometric quality, seeking out evidence of internal consistency, score reliability, and (in particular) measurement invariance. These methods were primarily based on confirmatory models, which the team deemed appropriate given the nature of the data. The results of these analyses are reported in Appendices J and K.

11.2.3 Confirmatory Factor Analysis

Confirmatory factor analysis (CFA) provided strong construct-related evidence regarding the factor structure of each OTL scale. Establishing the independence of each measure of OTL was important in terms of providing clear information about the extent to which each independent explanatory variable explained variation in the key outcomes of teacher preparation. CFA not only enables testing of data–model fit but also provides a means of assessing the usefulness of simpler versus more complex factor structures. TEDS-M's goal in this regard was to identify the most parsimonious set of OTL scales.

In order to complete the CFA for each set of OTL measures, the TEDS-M team used the statistical software package Mplus 5.2 (Muthén & Muthén, 1998). They initially assessed the factor structure, made up of the factors identified from prior research and the pilot results, across countries. To assess the degree to which these factor structures were invariant across countries, the team used multiple group confirmatory factor analysis (MCFA), which made it possible to test the fit of a given factor structure in each country, and from there defend (or otherwise) the meaningfulness of each OTL scale within and across countries. Particular features of Mplus MCFA, including its ability to accommodate missing data and complex survey data and to conduct single or multiple group analyses, made Mplus MCFA a strong application for TEDS-M (Muthén & Muthén, 1998).

Mplus also allows for non-normal continuous factor indicators, which the TEDS-M team employed when analyzing the OTL scales for the future teacher surveys. Some OTL scales were based on the numbers of topics studied, for example, the tertiary-level mathematics topics. The responses from these indicators included "studied"/"never studied," resulting in dichotomous responses (0/1). The remaining OTL scales were based on ordinal indicators on a four-point scale (ranging from either "never" to "often" or from "disagree" to "agree"). Mplus furthermore allows for proper CFA estimation of non-normal data, including accommodation of missing data. The default estimator for this type of analysis is a robust weighted least squares estimator, employing probit regression for factor estimation.

11.2.4 Rasch Scaling

Rasch scaling was used to produce the reporting score scale for the OTL scales. Rasch scaling provided measures of OTL with several scale (statistical) properties that made them stronger variables in general linear model (GLM)-based analyses. When the assumptions of a model are met, Rasch scales result in interval-level measurement, providing a scale with properties suited to correlational methods.

The improved scale properties relative to the use of a simple summed score is probably the most significant benefit of using Rasch scaling. *Rasch analysis* locates each indicator on the same scale as person-trait levels, providing for a meaningful ordering of indicators and so relaying information about the rarity or severity of each indicator (a form of item difficulty). *Rasch scaling*, in turn, provides an efficient means of estimating trait values for individuals who have not responded to every item. Scaling also makes it possible to conduct weighted analyses when estimating item locations on the trait scale. However, it is important to note that because the OTL scales conceptualized in the TEDS-M framework are indicators of program characteristics, they must be used in their aggregate form at the program level. Person-trait levels, as estimated by Rasch, are useful in this context as indicators of program characteristics.

To complete the scaling, the TEDS-M team scaled the OTL scales using a combined file of future primary and lower-secondary teachers across countries. Only those cases from within the file that responded to more than 50 percent of the items were included in the scaling. The team then recomputed the weights for each OTL scale, accounting for the variation in the resulting sample in terms of the inclusion criterion (i.e., response to more than 50% of the items within a scale). This criterion meant that the proportion of respondents responding to each scale differed from one country to the next. The weights were therefore adjusted again so that, in each country, they summed up to 500 for the primary-level population and 500 for the lower-secondary-level population. In other words, each country with primary and lower-secondary respondents contributed 500 primary and 500 lower-secondary units of observations to the final scaling. The weights could then be estimated through use of a simple transformation based on the resulting sample size and the effective sum of 500 for each population in each country. This first level of analysis with valid cases constituted the calibration sample.

The TEDS-M team estimated the Rasch item calibrations by using Winsteps (Linacre, 2010), with the partial-credit model. This model allowed each item to contribute different threshold values to each rating-scale point. The polytomous "partial credit" model as defined and estimated in Winsteps (Linacre, 2010, p. 18) is

$$\log\left(\frac{P_{nij}}{P_{ni(j-1)}}\right) = B_n - D_{gi} - F_{gj},$$

where P_{nij} is the probability that person n responds to item i in observed category j, and the Rasch parameters are B_n, the ability of the person, D_{gi}, the difficulty of item i of grouping g, and F_{gj} the threshold between categories j–1 and j of grouping g. This grouping convention allows each item to consist of its own grouping and so form its own rating-scale response structure. If there is only one grouping, that grouping aligns with Andrich's "rating scale" model. If each item forms a grouping of its own, such as $g = i$, then that grouping is Masters' "partial credit" model (Linacre, 2010). The model that the TEDS-M team used was the partial credit model. In allowing each item to have its own response structure, it provided a better fit to the data.

The next step involved using calibration values to provide scores for all cases responding to more than 50 percent of the items, regardless of validity status. This step was taken in order to provide scores for all cases, even those excluded as a result of sample adjudication. A country with not-included cases could therefore, if it considered it meaningful to do so, conduct full analyses of all its cases.

To facilitate improved score interpretation, the TEDS-M team rescaled the scores. Because of the one-to-one correspondence of summed scores to measure in the Rasch model, the team members were able to rely on the test characteristic curve to relocate final scale scores, wherein the scale score of 10 was associated with the midpoint of the raw score scale (the point half way between "never" and "often," or between "disagree" and "agree"). This procedure provided for a common interpretable metric for the OTL scales, such that 10 was associated with a midpoint regarding frequency, a neutral perspective regarding agreement, or a midpoint regarding the extent of preparedness (for example) for each scale.

The OTL scales (see Exhibit 11.1) were thus developed through exploratory and confirmatory analyses and the scaling procedure described above. Appendix J sets out the item loadings and model fit statistics for each OTL scale for the primary and lower-secondary future teacher questionnaires and for the teacher educator questionnaire. Appendix K includes the model fit statistics by country.

11.3 Development of the Beliefs Scales

The belief scales were based on items from research-based belief scales used in earlier studies.[1] After completion of the TEDS-M pilot, the TEDS-M team selected items from among those that survived exploratory factor analyses. A subset of highly homogeneous items per scale was selected for the operational forms. Additional Rasch rating-scale analyses were conducted to evaluate the effectiveness of the six-point rating scale (used by some belief scales), and support was found for its continued use. The complete analytical process mirrored that used for the OTL scales, as described above.

1 For more details, see the TEDS-M conceptual framework (Tatto et al., 2008).

Exhibit 11.1: Opportunity to learn scales

OTL Scale Label	Primary and Secondary Scales			Teacher Educator Scales		
	Section B question no.	*Item letter*	*Variable name*	*Section and question no.*	*Item letter*	*Variable name*
Tertiary-level mathematics—geometry	Q1	A, B, C, D	MFB1GEOM	None		
Tertiary-level mathematics—discrete structures and logic	Q1	F, G, H, I, P, S	MFB1DISC	None		
Tertiary-level mathematics—continuity and functions	Q1	J, K, L, M, N	MFB1CONT	None		
Tertiary-level mathematics—probability and statistics	Q1	Q, R	MFB1PRST	None		
School-level mathematics—numbers, measurement, geometry	Q2	A–C	MFB2SLMN	None		
School-level mathematics—functions, probability, calculus	Q2	D–G	MFB2SLMF	None		
Mathematics education pedagogy—foundations	Q4	A–C	MFB4FOUN	None		
Mathematics education pedagogy—instruction	Q4	D–H	MFB4INST	None		
Mathematics education pedagogy—class participation	Q5	B–F	MFB5PART	I1	B–F	MEI1PART
Mathematics education pedagogy—class reading	Q5	H–K	MFB5READ	I1	H–K	MEI1READ
Mathematics education pedagogy—solving problems	Q5	L–O	MFB5SOLV	I1	L–O	MEI5SOLV
Mathematics education pedagogy—instructional practice	Q6	L, N, Q, R, T, Z	MFB6IPRA	G2	C, E–I	MEG2IPRA
Mathematics education pedagogy—instructional planning	Q6	A, G–K, X	MFB6IPLA	I3	A, E–I, P	MEI3IPLA
Mathematics education pedagogy—assessment uses	Q6	O, P, U, V, W	MFB6AUSE	I3	J, K, M–O	MEI3AUSE
Mathematics education pedagogy—assessment practice	Q6	B–F	MFB6APRA	G2, I3	A–B, B–D	MEG2APRA
Education pedagogy—social science	Q7	A–C	MFB7EPSS	None		
Education pedagogy—application	Q7	D–H	MFB7EPAP	None		
Teaching for diversity	Q8	A–F	MFB8DVRS	H2	A–F	MEH2DVRS
Teaching for reflection on practice	Q8	G–J	MFB8REFL	H2	G–J	MEH2REFL
Teaching for improving practice	Q9	E–L	MFB9IMPR	H1	E–L	MEH1IMPR
School experience—connecting classroom learning to practice	Q13	A–H	MFB13CLP	I2	A–H	MEI2CLP
Supervising teacher reinforcement of university goals for practicum	Q14	A–E	MFB14STR	None		
Supervising teacher feedback quality	Q14	F–I	MFB14STF	None		
Program coherence	Q15	A–F	MFB15COH	J1	A–F	MEJ1COH

Exhibit 11.2: Beliefs scales

Beliefs Scale Label	Primary and Secondary Scales			Teacher Educator Scales		
	Section and question no.	*Item letter*	*Variable name*	*Section and question no.*	*Item letter*	*Variable name*
BELIEFS ABOUT THE NATURE OF MATHEMATICS						
Rules and Procedures	D1	A, B, E, G, K, L	MFD1RULE	K1	A, B, E, G, K, L	MEK1RULE
Process of Inquiry		C, D, F, H, I, J	MFD1PROC		C, D, F, H, I, J	MEK1PROC
BELIEFS ABOUT LEARNING MATHEMATICS						
Teacher Direction	D2	A–F, I, J	MFD2TEAC	K2	A–F, I, J	MEK2TEAC
Active Learning		G, H, K–N	MFD2ACTV		G, H, K–N	MEK2ACTV
BELIEFS ABOUT MATHEMATICS ACHIEVEMENT						
Fixed Ability	D3	A–H	MFD3FIXD	K3	A–H	MEK3FIXD
BELIEFS ABOUT THE PROGRAM AS A WHOLE						
Preparedness for Teaching Mathematics	D4	A–M	MFD4PREP	L1	A–M	MEL1PREP
Instructional Quality	D5	A–F	MFD5QUAL	None		

Using as their basis the outcomes of a series of confirmatory factor analyses, the TEDS-M team used the Rasch model to scale the belief scales. They then rescaled the results so that these centered at the point on the scale associated with the middle of the rating scale (essentially "neutral"). All TEDS-M belief scales are based on a score scale where 10 is located at the neutral position. The same process used with the OTL scales (i.e., based on rating-scale items) was therefore used for the beliefs scales (see Exhibit 11.2).

The team employed a second procedure to allow for descriptive displays of the data. When answering each belief-item statement in the TEDS-M instruments, respondents were asked to choose from six response alternatives: "strongly disagree," "disagree," "slightly disagree," "slightly agree," "agree," and "strongly agree." For descriptive display, TEDS-M saw Responses 5 and 6 (agree and strongly agree) as endorsing the statement, and Responses 1 through 4 (strongly disagree through slightly agree) as failing to endorse the statement. For any group of respondents, the proportion of responses endorsing the statements could then be presented as a measure of the group's endorsement of the belief. If 90 percent of responses fell into the agree and strongly agree categories, the group responses indicated strong support for the belief; if only 10 or 20 percent of responses fell into these categories, the belief was seen as receiving little support from the group. Display of summary data in this form made explicit just how much the TEDS-M countries and groups within these countries differed in the extent to which they endorsed the beliefs measured.

The TEDS-M team developed the beliefs scales (see Exhibit 11.2) through exploratory and confirmatory analyses and the scaling procedure described above. Appendices F, G, and H show the international reliabilities for the future primary teachers', future lower-secondary teachers', and educators' beliefs scales. Appendix K includes the model fit statistics by country.

The team used the item parameters calibrated from the future teachers as fixed parameters from which to estimate the scale scores for the educators' belief scales. This process placed the OTL and beliefs scale scores from educators on the same scales as those for future teachers, thereby facilitating comparative inferences. Appendix H provides information about the fit between the OTL and beliefs measures and the educator responses, as estimated by MPlus through a confirmatory factor analysis process.

11.4 Scaling Mathematics and Mathematics Pedagogy Content Knowledge and Determining Anchor Points

11.4.1 Measuring Mathematics Knowledge for Teaching

TEDS-M built on the Mathematics Teaching in the 21st Century (MT21) study (Schmidt, Blömeke, & Tatto, 2011), which developed an earlier and shortened version of a questionnaire designed to measure future lower-secondary teachers' knowledge of (1) mathematics, (2) mathematics pedagogy, and (3) general knowledge for teaching. These instruments were trialed on a small-scale basis in six countries in 2005 (Bulgaria, Chinese Taipei, Germany, Mexico, Republic of Korea, and the United States), with promising results, and served to inform the instrument development in TEDS-M.

Lessons learned from MT21 led to the addition of a substantial number of mathematics and mathematics pedagogy knowledge items to the TEDS-M questionnaire for future lower-secondary teachers. These additions were necessary in order to sufficiently test knowledge in these domains and to enable reporting by subscales. Similarly, and because MT21 did not study future primary teachers, TEDS-M developed or adapted a large number of items so that knowledge of these teachers could be sufficiently tested and enable reporting by subscales in the relevant domains. The TEDS-M research team developed some items and also solicited items from the Knowing Mathematics for Teaching Algebra (KAT) project at Michigan State University (Michigan State University Board of Trustees, 2006), the Learning Mathematics for Teaching (LMT) project at the University of Michigan (Consortium for Policy Research in Education, 2006), from researchers in ACER in Australia, and from the countries participating in TEDS-M.

Piloting of the items, which took place in June 2006, was followed by a field trial of the assessment instruments for most of the participating countries during March and April 2007. Thus, many of the items used in the main study were subject to as many as five rounds of international trialing in diverse countries.

At each stage of the item development process, expert panels examined the content validity and appropriateness of the items. These reviews took into consideration clarity, correctness, cultural relevance, classification within the framework of domains and subdomains, relevance to teacher preparation, and curricular level. Scoring guides and rubrics were prepared for all constructed-response items, and sample responses were collected to provide a basis for training the scoring team in each country.

All these materials were thoroughly reviewed and revised when appropriate in close collaboration with the NRCs. The scoring training sessions for NRCs were carried out in preparation for the field trial and in preparation for the main study. Further details on the methods design of the main study can be found in the TEDS-M conceptual framework (Tatto et al., 2008).

11.4.2 Scale Development

As described earlier in this report, the TEDS-M surveys assessing mathematics content knowledge (MCK) and mathematics pedagogical content knowledge (MPCK) used a balanced-incomplete-block design so that the desired content could be well covered but completed within a reasonable administration time. This design meant that each respondent took only part of the full set of items. Because the set of items taken by each respondent was not comparable, summing the scores on the items taken by each person would not have yielded meaningful results. To obtain comparable estimates of performance, the TEDS-M team used item response theory (IRT) in order to obtain estimates of performance on the same scale even when the set of items taken by each individual differed (see, for example, de Ayala, 2009, for a description of IRT methodology).

The first step in the process for obtaining the reporting score scales involved calibrating the test items and then evaluating the results to determine how well the IRT models fitted the data. Items with poor fit and items that showed other violations of assumptions of the models were carefully reviewed. Some of these items were removed from the computation of the reported scores. Others required modifications to the scoring procedures, such as combining score categories on items with multiple score points. Appendices L and M provide a full record of the item modifications and deletions along with the rationale for each decision.

After completing this review and revision process, the team again calibrated the sets of items using weights to ensure that each country made the same contribution to the calibration. Details of this process follow.

11.4.2.1 Calibrations and weights

Item response models from the Rasch family were used to carry out calibration. In order to fit the matrix of item scores, the TEDS-M team used the standard Rasch model (Rasch, 1980) for the dichotomous items and the partial credit model (Masters, 1982) for the polytomous items. They then analyzed both item types simultaneously using the ACER Conquest software (Wu, Adams, Wilson, & Haldane, 2007).

At each stage of the calibrations, analyses were first conducted at ACER, and the results sent to MSU. Although prior agreement had been reached about the details of the calibrations (e.g., which items would be included and which excluded, how missing data would be treated), the two centers conducted their analyses independently and compared results. If results differed, the reasons were identified and the analyses repeated until agreement was reached. Appendix N presents the control parameters for calibration and case estimation for the MCK and MPCK items. Appendix O shows the individual items that formed each of the knowledge scales.

The final calibration results were used to estimate the location of the examinees on a common IRT scale for MCK and MPCK for the primary and lower-secondary levels respectively. These results were then transformed to the reporting score scales. The IRT scores were transformed so that the international mean for the calibration sample on each of the MCK and MPCK scales was 500, and the international standard deviation was 100.

11.4.2.2 Score generation

After calibration, the item parameter estimates were used to estimate achievement for each respondent. In accordance with standard practice, items at the end of blocks without responses were considered as "not reached." These items were treated as "missing" in the calibration, but were scored as "incorrect" during the estimation of scores for individuals.

11.4.2.3 Standardization

Standardization was carried out using the data from the calibration. The achievement estimates (in logits) were standardized to a mean of 500 and a standard deviation of 100, with all countries weighted so that they would contribute equally to the standardization sample. This process was repeated for each of the four key measures: MCK (primary), MCK (lower secondary), MPCK (primary), and MPCK (lower secondary).

Once standardization was completed, the TEDS-M team computed scores for all respondents for whom MCK and MPCK estimates could be obtained, including those not included in the standardization sample. The mean of 500 and the standard deviation of 100 applied to the calibration sample rather than to the complete set of scores.

11.4.3 TEDS-M Test Reliabilities

Appendix P shows the reliabilities for the MCK and the MPCK tests for the primary and the lower-secondary international samples. Note that the reliability estimates vary from 0.66 to 0.91. These differences occurred because reliability is a sample-specific statistic. Reliability will be high if there is considerable variation in the sample relative to the size of the standard error, as was the case for the TEDS-M international (total) sample. The reliability will be low if one of the following occurs:

- There is a small standard deviation of the sample; or
- If there is a large standard error (e.g., the test is too easy for some of the respondents, which means the test did not serve as a good measure).

The standard error is a much better indicator of the precision of measurement because it is not influenced by the standard deviation of the sample (smaller standard errors are preferable to larger standard errors). In TEDS-M, the MCK standard errors were much smaller than the MPCK standard errors because of the difference in the number of items used for these respective areas of the survey instruments.

The following formula was used to compute the reliability of the individual scores:

$$r_{\theta\theta} = \frac{s_{\hat{\theta}}^2 - s_{\theta}^2}{s_{\hat{\theta}}^2} \quad .$$

Here, $s_{\hat{\theta}}^2$ is the variance of the estimated IRT estimates for the sample being considered, and s_{θ}^2 is the mean variance of error for estimating the IRT score for the persons in the sample. The standard error is computed by taking the square root of s_{θ}^2.

Two matters need to be considered when interpreting these reliabilities. First, they are estimates of the reliability of individual scores. However, individual scores are always more variable than group scores, which are at the heart of the TEDS-M conceptual framework. The recommended unit of analysis was a group-level unit, primarily based on the level at which future teachers were being prepared to teach. Because group scores are more consistent and stable, their reliabilities will be significantly higher. Although there are many guidelines on this matter throughout the research literature, most researchers and commentators consider internal-consistency estimates of reliability at or above 0.70 to be adequate for research purposes, whereas reliabilities of 0.90 or higher are desired for making individual-level decisions.

11.4.4 Methods Used to Determine MCK and MPCK Anchor Points

11.4.4.1 Developing the anchor points

TEDS-M also used the calibration results to identify anchor points for the score scales. Anchor points are specific values on a score scale that tie into descriptions of what respondents at those points know and can do. TEDS-M identified two sets of test items that could support the development of descriptions of the skills and knowledge at each of the anchor points. The first set included those items that a person at that anchor point on the scale score would be able, according to the IRT model, to answer correctly with a probability of 0.70 or greater. The other set included those items that a person at that anchor point on the scale score would be able, based on the IRT model, to answer correctly with a probability of 0.50 or less.

The anchor points selected were those that would provide a sufficient number of items (between 10 and 12) of each type and so enable development of a description of the skills and knowledge of a person at that anchor point. Given these requirements, TEDS-M identified two anchor points for the MCK scales for the primary and lower-secondary levels. Anchor Point 1 represented a lower level of performance, and Anchor Point 2 represented a higher level. Only one anchor point was selected for the MPCK scales because there were fewer items measuring MPCK than MCK (see Chapter 3 of this report).

For each of the anchor points, a panel of experts conducted detailed analyses of the two sets of items so that descriptions of the capabilities of persons near each point on the scale could be developed. These descriptions were produced by committees of mathematicians and mathematics educators who participated in workshops set up specifically for this task (see the appendix to the TEDS-M international report; Tatto et al., 2012). The resulting anchor point descriptions, provided in Appendix Q, give tangible meaning to the points on the reporting score scales. Chapter 5 of the TEDS-M final report (Tatto et al., 2012) includes the graphics depicting the results of the knowledge tests by program-type grouping. Box plots and horizontal lines show the locations of the anchor points.

11.4.4.2 Conversion to standard score scales

The mean and standard deviation (*SD*) for primary MCK were 0.01 and 1.18, respectively, on the logit scale from ConQuest. The corresponding primary MCK scale scores for anchor points -0.8 and 0.2 on the scale used for reporting the international results were 431 and 516 respectively. The mean and *SD* for primary MPCK were -0.07 and 1.07 on the ConQuest logit scale. For anchor point 0.4, the corresponding scale score was 544.

For lower-secondary MCK, the mean and *SD* were -0.01 and 1.02 on the ConQuest logit scale. The corresponding scale scores for -0.2 and 0.5 were 490 and 559 respectively. The mean and *SD* for lower-secondary MPCK were -0.11 and 1.16 on the ConQuest logit scale. The corresponding scale score for 0.0 was 509 on the reporting score scale.

11.4.5 Reporting Knowledge Scales

Although the MCK measures differed for future primary and future lower-secondary teachers, and were different from the MPCK measures, all measures were standardized in the same way. Readers unfamiliar with the details may therefore see these measures as comparable, but they are not. In order to avoid the possibility of confusion, these measures were reported separately in the TEDS-M international report (Tatto et al., 2012), and effort was made to ensure that none of the charts presented lined up primary against lower secondary, or MCK against MPCK.

11.4.5.1 Country comparisons

TEDS-M acknowledges that "teacher education is understood and structured differently across national settings and even between institutions in the same country" (Tatto et al., 2008, p. 17). The initial chapters of this report detail the many ways in which the structure of teacher education programs differed across the 17 countries participating in TEDS-M. As such, the teaching roles for which the two populations of future teachers (primary and lower secondary) were being prepared differed substantially.

Among those future teachers who would qualify to teach at the primary level, for example, most would qualify to become generalist teachers across all primary levels, which, depending on the country, may have been Grades 6, 7, or 8. Some would become generalist primary teachers qualified to teach classes no higher than Grade 4. Others would qualify to become specialist teachers of mathematics throughout primary school and, in some cases, on into secondary school. Similarly, among those qualifying to teach mathematics in the lower-secondary school, some would be qualified to teach only up to Grade 8, while others would become mathematics specialists qualified to teach to Grade 12 and beyond.

In other IEA studies, such as the Trends in International Mathematics and Science Study (TIMSS), the population definitions yield a more consistent pattern of participants across countries. In TIMSS, the two populations of interest (fourth- and eighth-grade students) have a high degree of commonality across countries. The samples chosen at each of these levels differ very little across countries with respect to their average age[2] and their years of schooling at the time of testing. It makes sense, therefore, for those reporting TIMSS results to compare whole countries.

While it is equally possible to provide comparisons of countries in TEDS-M, the intent of the study has always been to conduct country comparisons only within program-groups, even though, in some cases (e.g., Chinese Taipei and the Russian Federation), there was only one program-type at each of the primary and secondary levels. TEDS-M also has not favored whole-country comparisons because such comparisons typically compare like with unlike. Presentation of TEDS-M results is therefore directed, to the greatest extent possible, at comparing like with like: in this case, teachers who are being prepared to undertake similar roles once they are qualified.

11.4.5.2 Program-groupings

The programs that future teachers undertake can be grouped according to the level at which these individuals will qualify to teach, and the degree of specialization in the teaching role that they qualify to undertake. Appendices R and S show how these program-groups differ from one country to another. In TEDS-M, four program-groups could be readily identified at the primary level, and two readily identified at the secondary level:

- *Future primary teachers*
    1. Generalists, no higher than Grade 4
    2. Generalists, no higher than Grade 6
    3. Generalists, no higher than Grade 10
    4. Mathematics specialists.
- *Future secondary teachers*
    5. Lower secondary, no higher than Grade 10
    6. Lower and upper secondary, above Grade 10.

These grouping were used as the basis for reporting the MCK and MPCK score summaries.

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2 This is because of the way TIMSS defines grade level.

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Appendices

APPENDIX A:

TEDS-M 2008 Route Questionnaire

TEDS-M

Identification Label

IEA – Teacher Education Study in Mathematics (TEDS-M)

TEDS-M 2008

ROUTE QUESTIONNAIRE

<TEDS-M National Research Center Name>
<Address>
TEDS-M Route Questionnaire

TEDS-M Route Questionnaire

TEDS-M is a study of the routes of mathematics teacher education. By “route” we mean the sequence of opportunities, programs, examinations, etc which lead future teachers from the end of secondary school to being considered fully qualified to teach in primary or lower-secondary school. We identify routes in order to be clear on how they differ in major respects, such as the entry requirements, the structure, the curriculum, the capabilities and backgrounds of their students, the hurdles over which these students must pass and finally of course the different grade levels and types of schools for which each route prepares graduates.

One reason we have to be clear about the routes in each country is that this is essential to comparability of analyses. In comparing routes across countries, we have to be able to distinguish easily, for example, between routes in which formal teacher education follows the completion of a university degree (known as *consecutive* routes) and routes in which formal teacher education and subject preparation are combined into a single program (*concurrent* routes).

If you need further clarification on any aspect of this questionnaire before completing it, please send your questions of clarification by email to teds@msu.edu.

Country ______________________

Person responsible for preparing this response: ______________________

Contact email: ______________________

Contact telephone: ______________________

Contact fax: ______________________

Sources used in answering questionnaire (check all that apply):

- ☐ Official documents
- ☐ Research documents
- ☐ Other documents
- ☐ Focus groups
- ☐ Interviews
- ☐ Firsthand knowledge of person preparing response
- ☐ Other (please specify) ______________________

Special questions and instructions for federalized countries where teacher education policy is set more at the <state/province> level than at the national level: For such countries there are three options for responding to questions in this questionnaire for which there is no appropriate answer at the national level:

- Option 1 (preferred)—answer questions in terms of what is typically the case at the <state/province> level
- Option 2—when it does not make sense to answer in terms of the typical case, answer the question twice, illustrating the case of the two <states/provinces> which differ the most with respect to the question being asked.
- Option 3—when there is no appropriate answer at either national or <state/province> level, simply write on the questionnaire "no policy at state or national level".

To make sure we are clear about this, please record below the question number for each of the questions in which one of these options was used:

- Option 1 was used in Questions ______________________________________
- Option 2 was used in Questions ______________________________________
- Option 3 was used in Questions ______________________________________

SECTION ONE—LEGISLATIVE/REGULATORY FRAMEWORKS

1. In your country, is there a legislative/regulatory framework or frameworks to set requirements that teacher-preparation programs must meet in order for their graduates to be recognized as qualified for employment as teachers?

   ☐ Yes

   ☐ No

If no, skip to Question 6

2. Is the legislative/regulatory framework set by

   ☐ The national government?

   ☐ State or provincial governments?

   ☐ Both national and state/provincial?

   ☐ Other, please describe:

   ____

3. If possible, please provide a web address or addresses for national-level information on this legislative/regulatory framework, or a copy of any relevant documentation about the legislative/regulatory policy framework.

   ____

4. Do any of the legislative/regulatory frameworks that govern teacher preparation in your country set requirements about the content that students must be taught in their teacher preparation programs?

   ☐ Yes

   ☐ No

5. Is there a national written set or sets of competencies or standards that teacher education routes or programs are required to develop in their graduates? (If so, please provide a full reference in the following space and attach a copy.)

   ☐ Yes

   ☐ No

Reference:

SECTION TWO—OVERALL STATISTICS FOR USE IN CALCULATING THE RELATIVE SIZE OF EACH ROUTE

6. What is the total number of ISCED 1 primary school teachers in your country (public and private schools)? ____________________

7. What is the highest grade level included in this statistic? ____________________

   Lowest grade level? ____________________

8. What is the total number of ISCED 2 secondary school teachers in your country (public and private schools)? ____________________

9. What is the highest grade level included in this statistic? ____________________

   Lowest grade level? ____________________

10. Give the source of these statistics: ____________________

11. Attach a listing breaking these numbers of primary and secondary school teachers down by grade level if available.

SECTION THREE—ROUTE BY ROUTE DATA

For countries which have more than one route, a SECTION THREE response is required for each route to be studied in TEDS-M (i.e., the selection of routes based on the Frame Questionnaire as agreed upon by the NRC, the TEDS-M sampling reference, and the DPC).

12. TEDS-M route ID ____________________
13. Name of route ____________________
14. Country ____________________

Type of Route

Of the following three boxes, answer only the one that is most applicable to this route. These boxes differentiate among three types of routes: concurrent, consecutive, and primarily practice (apprenticeship). These questions expand upon the frame questionnaire in order to document more clearly and adequately the characteristics of each route selected for study.

Concurrent route: A concurrent route may have one or two phases as follows: If the ***first phase*** of a route consists of a single program that includes studies in the subjects future teachers will be teaching (academic studies), studies of pedagogy and education (professional studies) and practical experience in the classroom, the route is indeed a **concurrent** route. The ***second phase***, if it exists, consists of on-the-job probationary experience, required for <certification/licensure/registration>, but not under the control of the first phase institution.

15. Is this route a **concurrent** route? ___ yes ___ no

If no, skip to Question 35.

First phase of concurrent route

16. If yes, how long do students following the recommended schedule typically take to complete this **first phase** of the concurrent route?

    ___ months (do <u>not</u> count breaks or vacations of one month or more)

17. By what name is this first phase generally known in your country? (Give national terminology and English translation.) ____________________

18. What are the institution(s) in which this first phase takes place called? (Give national terminology and English translation.) ____________________

19. In the latest year for which figures are available, how many institutions offered the first phase of this route? ____________________

20. Source of data for this response: ____________________

21. What is the minimal credential/qualification normally required for entry into this route?
    - ☐ Completion of <lower-secondary> school
    - ☐ Completion of <upper-secondary> school
    - ☐ Completion of post-secondary, non-tertiary school
    - ☐ Completion of higher-education degree <ISCED 5>
    - ☐ Completion of higher-education degree <ISCED 6>
    - ☐ Completion of a degree <ISCED 7>
    - ☐ Other (please specify) ______________________

22. In terms of their prior academic achievement, students entering the first phase of this route would typically be drawn from:
    - ☐ Very high achievers (e.g. the top 10 percent of their age group)
    - ☐ High achievers (e.g. the top 20 percent of their age group)
    - ☐ Above-average achievers (for their age group)
    - ☐ Average achievers (for their age group)
    - ☐ Average and below-average achievers (for their age group)
    - ☐ Below-average achievers (for their age group)
    - ☐ Other (please explain) ______________________

23. Is the credential/qualification required for entry into this route determined by (check all that apply):
    - ☐ A national legislative/regulatory framework?
    - ☐ A state, provincial, or regional regulatory framework?
    - ☐ The requirements set by employers or professional organizations?
    - ☐ Teacher-preparation institutions, by mutual agreement?
    - ☐ Teacher-preparation institutions, acting individually?

24. What national or regional external examination(s), if any, is/are taken during or at the end of this first phase? (Use national terminology with brief description of what is being tested and how the results are used.)

    ____

25. What credential/qualification is earned at the end of this first phase? (Give ISCED level, national terminology, and English translation.) ______________________

26. What national documents (if any) set standards and requirements for the curriculum content of this route? (Give national title, English translation, and brief description of what the document contains.)

    ____

    ____

    ____

27. Further clarification or explanation if needed:

Second phase of concurrent route—an on-the-job phase

28. Is there a second **phase** of on-the-job probationary experience, not under the control of the first phase institution, but required to be certified as fully qualified? ___ yes ___ no

If no, skip to Question 73.

29. By what name is this second phase generally known in your country? (give national terminology and English translation) ______________________________

30. How long is this final on-the-job phase? ___ months (do not count breaks or vacations of one month or more)

31. Is there any training institution (other than the elementary or secondary school in which the on-the-job phase takes place) which is responsible for supporting future teacher learning during this phase? ___ yes ___ no

If no, skip to Question 33.

32. If yes, what is the name of this support institution? (Give national terminology and English translation.) ______________________________

33. What national or regional external examination(s), if any, is/are taken during or at the end of this second phase? (Use national terminology with brief description of what is being tested and how the results are used.) ______________________________

____

____

34. What credential/qualification is earned at the end of this second phase? (Give ISCED level, national terminology, and English translation.)

____

____

____

Skip to Question 73.

Consecutive route: A consecutive route may have two or three phases as follows: If the route consists of a ***first phase*** for academic studies (leading to a degree or diploma), followed by a ***second phase*** of professional studies and practical experience (leading to a separate credential/qualification), the route is indeed a **consecutive route**. The ***third phase***, if it exists, consists of on-the-job probationary experience, required for <certification/licensure/registration>, but not under the control of the second phase institution.

35. Is this route a **consecutive** route? ___ yes ___ no

If no, skip to Question 35.

First phase of consecutive route

36. If yes, how long do students following the recommended schedule typically take to complete the first phase of academic studies? ___ months (do not count breaks or vacations of one month or more)

37. By what name is this first phase generally known in your country? (Give national terminology and English translation.)

____

38. What are the institution(s) in which this first phase takes place called? (Give national terminology and English translation.) ______________________________

39. In the latest year for which figures are available, how many institutions offered the first phase of this route? ______________________________

40. Source of data for this response: ______________________________

41. What is the minimal credential/qualification normally required for entry into this route?

- ☐ Completion of <lower-secondary> school
- ☐ Completion of <upper-secondary> school
- ☐ Completion of post-secondary, non-tertiary school
- ☐ Completion of higher-education degree <ISCED 5>
- ☐ Completion of higher-education degree <ISCED 6>
- ☐ Completion of a degree <ISCED 7>
- ☐ Other (please specify) ______________________________

42. What national or regional external examination(s), if any, is/are taken during or at the end of this first phase? (Use national terminology with brief description of what is being tested and how the results are used.)

____

____

43. What credential/qualification is earned at the end of this first phase? (Give ISCED level, national terminology, and English translation.)

____

44. Further clarification or explanation if needed:

Second phase of consecutive route

45. How long do students following the recommended schedule typically take to complete the **second phase** of professional studies and practical experience? ___ months (do <u>not</u> count breaks or vacations of one month or more)

46. What are the institution(s) in which this second phase takes place called? (Give national terminology and English translation.) ______________________________

47. In the latest year for which figures are available, how many institutions offered the second phase of this route? ______________________________

48. Source of data for this response: ______________________________

49. Is the second phase of the route (professional studies, including practical experience) normally done in the same institution as the first phase (subject preparation or studies in disciplines other than education)?
    - ☐ Always in the same institution
    - ☐ Sometimes in the same institution, sometimes in other institutions
    - ☐ Never in the same institution

50. What national or regional external examination(s), if any, is/are taken during or at the end of this second phase? (Use national terminology with brief description of what is being tested and how the results are used.)

    ____

    ____

51. What credential/qualification is earned at the end of the second phase? (Give ISCED level, national terminology and English translation.)

    ____

52. In terms of their prior academic achievement, students entering the second phase of this route would typically be drawn from:
    - ☐ Very high achievers (e.g., the top 10 percent of their age group)
    - ☐ High achievers (e.g., the top 20 percent of their age group)
    - ☐ Above-average achievers (for their age group)
    - ☐ Average achievers (for their age group)
    - ☐ Average and below-average achievers (for their age group)
    - ☐ Below-average achievers (for their age group)
    - ☐ Other (please explain) ______________________________

53. Is the qualification required for entry into the second phase of this route determined by:
    - ☐ A national regulatory framework?
    - ☐ A state, provincial, or regional regulatory framework?
    - ☐ The requirements set by employers or professional organizations?
    - ☐ Teacher-preparation institutions, by mutual agreement?
    - ☐ Teacher-preparation institutions, acting individually?

54. What national documents (if any) set standards and requirements for the curriculum content of this route (give national title, English translation, and brief description of what the document contains.

    ____

    ____

    ____

55. Further clarification or explanation if needed:

Third phase of consecutive route—an on-the-job phase

56. Is there a third phase of on-the-job probationary experience, not under the control of the first or second phase institution, but required to be certified as fully qualified? ___ yes ___ no

If no, skip to Question 73.

57. How long is this third on-the-job phase? ___ months (do <u>not</u> count breaks or vacations of one month or more)

58. Is there any training institution (other than the elementary or secondary school in which the on-the-job phase takes place) which is responsible for supporting future teacher learning during this phase? ___ yes ___ no

59. If yes, what is the name of the support institution? (Give national terminology and English translation.) ____

60. What national or regional external examination(s), if any, is/are taken during or at the end of this third phase? (Use national terminology with brief description of what is being tested and how the results are used.)

    ____

    ____

    ____

61. What credential/qualification is earned at the end of this third phase? (Give ISCED level, national terminology, and English translation.)

____

Skip to Question 73.

Primarily practice (apprenticeship) route: If the route consists predominantly of school-based experience with other institutions playing only a minor, marginal, or supporting role, the route is a primarily practice or apprenticeship route.

62. Is this route a **primarily practice (apprenticeship)** route? ___ yes ___ no

If no, skip to Question 73.

63. If yes, how long do trainees following the recommended schedule typically take to complete this route? ___ months (do not count breaks or vacations of one month or more)

64. What is the minimal credential/qualification normally required for entry into this route?
    - ☐ Completion of <lower-secondary> school
    - ☐ Completion of <upper-secondary> school
    - ☐ Completion of post-secondary, non-tertiary school
    - ☐ Completion of higher-education degree <ISCED 5>
    - ☐ Completion of higher-education degree <ISCED 6>
    - ☐ Completion of a degree <ISCED 7>
    - ☐ Other (please specify) ______________________

65. In terms of their prior academic achievement, students entering this route would typically be drawn from:
    - ☐ Very high achievers (e.g., the top 10 percent of their age group)
    - ☐ High achievers (e.g., the top 20 percent of their age group)
    - ☐ Above-average achievers (for their age group)
    - ☐ Average achievers (for their age group)
    - ☐ Average and below-average achievers (for their age group)
    - ☐ Below-average achievers (for their age group)
    - ☐ Other (please explain) ______________________

66. Is the qualification required for entry into this route determined by (check as many as apply):
    - ☐ A national regulatory framework?
    - ☐ A state, provincial, or regional regulatory framework?
    - ☐ The requirements set by employers or professional organizations?
    - ☐ Teacher-preparation institutions, by mutual agreement?
    - ☐ Teacher-preparation institutions, acting individually?

67. Is there any training institution (other than the elementary or secondary school in which the on-the-job phase takes place) which is responsible for supporting future teacher learning during this route? ___ yes ___ no

68. If yes, what is the name of the responsible institution (give national terminology and English translation) ______________________

69. What national or regional external examination(s), if any, is/are taken during or at the end of this route? (Use national terminology with brief description of what is being tested and how the results are used.) ______

70. What credential/qualification is earned at the end of this route? (Give ISCED level, national terminology, and English translation.) ______

71. What national documents (if any) set standards and requirements for the curriculum content of this route? (Give national title, English translation, and brief description of what the document contains.) ______

72. Further clarification or explanation if needed:

Continue with Question 73.

73. If you think that the above boxes misrepresent this route, please explain as clearly as possible how it differs from concurrent, consecutive, and apprenticeship programs as characterized above. Otherwise, leave blank.

Other Characteristics of the Route

74. Which of the following needs for teachers is this route especially designed to address? (Check all that apply.)
    - ☐ General shortage of teachers
    - ☐ Shortage of sufficiently competent teachers
    - ☐ Shortage of mathematics teachers
    - ☐ Shortage of teachers in schools with the most challenging conditions
    - ☐ Shortage of female teachers
    - ☐ Shortage of male teachers
    - ☐ Shortage of teachers from underrepresented ethnic, religious, or regional groups
    - ☐ Other (please specify) ______________________________
    - ☐ None of the above

75. This route can be undertaken by:
    - ☐ Full-time students only
    - ☐ Part-time students only
    - ☐ Full-time or part-time students
    - ☐ The answer differs by phase (please explain)

      ____

76. If the route is available to part-time students, what percent would you estimate of the cohort beginning in year 2005 was enrolled part-time?

    ____ %

    ____ data not available

77. Is entry to this route restricted to certain types of high schools or tracks within high school?

    ___ yes ___ no

    If yes, specify school types and tracks (English and non-English terms).

    ____

    ____

78. How many fields are graduates of this route normally qualified to teach?

    (By "field" we mean the following six groupings of school subjects: (1) mathematics, (2) science, (3) official language of the country, including literature, (4) foreign or second languages, (5) social studies, (6) other (art, music, physical education, vocational training, etc.)
    - ☐ Only one
    - ☐ Two
    - ☐ More than two
    - ☐ Varies (no clear national policy)

79. **Selection criteria:** How much importance, if any, does national policy give to each of the following criteria for selection to and within this route? If selection decisions are made at more than one point in the route, base your judgment on the overall importance of the criterion within the route.

Check one box in each row.

		Not considered	*Not very important*	*Quite important*	*Very important*
A.	The candidates' overall level of attainment in their final year of secondary schooling	☐	☐	☐	☐
B.	The candidates' performance on a national tertiary education entrance examination	☐	☐	☐	☐
C.	The candidates' performance in an examination specifically for admission to this training institution	☐	☐	☐	☐
D.	Interviews (e.g., about their reasons for wishing to become teachers, etc.)	☐	☐	☐	☐
E.	Excellence in mathematics at a level set by this institution	☐	☐	☐	☐
F.	Performance on tests of teaching competencies	☐	☐	☐	☐
G.	Previous work experience; please describe below	☐	☐	☐	☐
H.	Gender (if so, please describe below)	☐	☐	☐	☐
I.	Other groups believed to be under-represented in the teaching profession (if so, please describe below)	☐	☐	☐	☐
J.	The order in which the candidates apply	☐	☐	☐	☐
K.	Their region of residence	☐	☐	☐	☐
L.	The age of the candidates	☐	☐	☐	☐
M.	Other criteria; please describe below	☐	☐	☐	☐

Additional information on selection:

80. In selecting students for this route, do you make a special effort to include students who are already in the full-time workforce but are preparing to make a career change?
    - ☐ Yes
    - ☐ No

81. What percent of your national 2005 intake to this route were students who had already been in the full-time workforce and were preparing to make a career change?
    - ☐ %
    - ☐ data not available

82. **Content of route:** In the documentation containing national policy for this route, how much weight is given to each of the listed goals? (If the program prepares subject-matter specialists, answer in terms of persons preparing to be mathematics teachers.) Also answer in terms of what happens in the route as a whole, not on what happens in just one phase (e.g., in a consecutive route, mathematics content may be given major weight even though it is not addressed at all in the second-phase institution).

Check one box in each row.

Program Goals		*Little or no weight*	*Some weight*	*Moderate weight*	*Major weight*
Curriculum content knowledge					
A.	Study of the curriculum content to be taught in schools	☐	☐	☐	☐
B.	Study of the mathematics content in the school curriculum	☐	☐	☐	☐
C.	Study of mathematics at tertiary level	☐	☐	☐	☐
D.	Study of other disciplines at tertiary level	☐	☐	☐	☐
Pedagogical content knowledge					
E.	Study of pedagogy/teaching methods specific to the teaching of mathematics	☐	☐	☐	☐
F.	Strategies for teaching particular topics in mathematics	☐	☐	☐	☐
G.	Knowledge about students learning in mathematics	☐	☐	☐	☐
H.	Knowing common misunderstandings in mathematics	☐	☐	☐	☐
I.	Knowing how to build on students' prior knowledge in mathematics	☐	☐	☐	☐

Check one box in each row.

Program Goals		*Little or no weight*	*Some weight*	*Moderate weight*	*Major weight*
General pedagogy/educational foundations					
J.	Learning classroom management skills				
K.	Managing disruptive students				
L.	Planning lessons based on recommended pedagogical principles				
Assessing learning					
M.	Knowing how to develop good assessment tools				
N.	Using formative assessment to plan learning activities				
O.	Conducting fair and valid summative assessments of student learning				
P.	Using data from externally-conducted tests to judge the effectiveness of teaching				
Knowledge of students and diversity					
Q.	Study of child development				
R.	Strategies for teaching students from varied cultural backgrounds				
S.	Strategies for teaching students with behavioral problems				
T.	Strategies for teaching students who have learning disabilities				
U.	Strategies for teaching exceptionally gifted students				
V.	Strategies for teaching groups of students who are extremely diverse in abilities and interests				
Preparation for further development as a teacher					
W.	Developing the ability to do teacher action research				
X.	Learning to reflect on one's own learning and teaching practices				
Y.	Learning to improve one's own teaching by working with other teachers				

Check one box in each row.

	Program Goals	*Little or no weight*	*Some weight*	*Moderate weight*	*Major weight*
Understanding the school environment					
Z.	Study of the context and type of community in which future teachers are likely to teach	☐	☐	☐	☐
AA.	Learning to adjust to schools as they really are	☐	☐	☐	☐
AB.	Becoming a change agent in the educational system	☐	☐	☐	☐
AC.	Knowledge of the school system in a particular nation/state/district	☐	☐	☐	☐
AD.	Knowledge of legal and professional standards/ requirements for teachers	☐	☐	☐	☐

Further clarification or explanation if needed:

83. Which national requirements do students need to meet at least once during this route? (Check all that apply.)

- ☐ Pass each of the required subjects
- ☐ Pass a comprehensive written examination/assessment
- ☐ Pass a comprehensive oral examination/assessment
- ☐ Pass an examination set by national or state/provincial authorities
- ☐ Pass a portfolio required by the institution (not just by individual instructors)
- ☐ Pass an examination set by one of the institutions in the route
- ☐ Successfully demonstrate a required level of teaching competence in a classroom
- ☐ Write and defend a thesis
- ☐ Others (please specify below)
- ☐ None of the above

Further clarification or explanation if needed:

84. **Field experience and practicum:** Practical experience refers to future teachers' field experience in school settings during their teacher education program. This experience may take many forms and include a range of activities. In TEDS-M, the term practicum is used solely for classroom-based practical experience during the final year of one of the phases in a route.

Please use the following table for all field experience prescribed by national policy, including but not limited to the final year practicum. Indicate, according to national policy, at what times and for how many days future teachers in this route are assigned to school settings (assuming normal progress).

☐ Not prescribed or recommended by national policy in this detail—**Skip to Question 85**.

Fill in the following table for all phases of this route. If the route runs for a more limited number of years, simply leave the remaining cells in the table blank. Conversely, if the route runs for more than five years, add cells to the table as needed.

	Year 1		*Year 2*		*Year 3*		*Year 4*		*Year 5*	
Semester	1	2	1	2	1	2	1	2	1	2
Number of days in school setting										

Further clarification or explanation if needed:

85. In the practicum component of a route, the persons assigned to mentor and assess future teachers vary greatly across countries.

In the first column below, check off the category or categories of persons who are typically responsible for **mentoring and/or supervising** future teachers in the school(s) to which they are assigned for their practicum?

In the second column, check off the category or categories of persons who are typically responsible for **overall assessment** of the future teacher's practicum performance?

	Mentoring	Assessment
Practicing classroom teacher in elementary or secondary school	☐	☐
Headmaster or other administrator in a particular elementary or secondary school	☐	☐
Inspector, pedagogical advisor, or other midlevel administrator in elementary/secondary school system	☐	☐
Post-graduate student in a university	☐	☐
Other more senior university/college teaching staff	☐	☐
Retired elementary or secondary school teacher or administrator	☐	☐

Other (please specify) ______________________________

86. For assessment of the practicum component of this route, is there any national guidance provided to those who do the assessment? ___ yes ___ no

Clarification or explanation if needed: (e.g., if answer differs by phase and/or by <state/province>):

87. From a national perspective, finding places for students to complete the practicum component of this route is usually

- ☐ Quite easy; there are more places available than are needed by the program
- ☐ A little difficult; there is a fine balance between the number of places available and the number needed
- ☐ Extremely difficult; there are too few places available

Additional comment if needed:

88. **Where are standards set?** Who makes the decisions about the curriculum for all phases of this route, including expected outcomes or standards of performance? If the appropriate answer lies between "State or Provincial" and "Institutional," please check the answer "Regional or District" and add a brief explanation in the box that follows. Preferably a focus group of teacher education authorities should be used to answer this question.

Program Goals		Mostly determined at which level? (Please check one box in each row)				
		National	*State or provincial*	*Regional or district*	*Institutional*	*Does not apply*
General pedagogy/educational foundations						
A.	Program goals and emphasis	☐	☐	☐	☐	☐
B.	Selection of textbooks, teaching materials, readings	☐	☐	☐	☐	☐
C.	Standards of classroom performance expected of graduates	☐	☐	☐	☐	☐
D.	Standards of content knowledge expected of graduates	☐	☐	☐	☐	☐
E.	Subject-matter knowledge to be covered in mathematics	☐	☐	☐	☐	☐
F.	Mathematics pedagogy curriculum	☐	☐	☐	☐	☐
G.	General pedagogy/educational foundations curriculum	☐	☐	☐	☐	☐
H.	<General education> curriculum	☐	☐	☐	☐	☐
I.	Number of credits required in program areas	☐	☐	☐	☐	☐
J.	Length of practical training	☐	☐	☐	☐	☐
K.	Location of practical training	☐	☐	☐	☐	☐
L.	Monitoring of future teachers' progress through the program	☐	☐	☐	☐	☐
M.	Quality and frequency of the supervision during practical training	☐	☐	☐	☐	☐
N.	Type and content of assessments throughout the program	☐	☐	☐	☐	☐
O.	External examinations (if any)	☐	☐	☐	☐	☐
P.	Other ____________________	☐	☐	☐	☐	☐

Additional explanation if necessary:

89. Which of the following are required of most mathematics **content** teaching staff in this route? (Check as many as apply.)
    - ☐ Bachelor's degree (ISCED level ______)
    - ☐ Master's degree (ISCED level ______)
    - ☐ Doctoral degree (ISCED level ______)
    - ☐ A teaching credential/qualification for elementary or secondary school
    - ☐ Experience teaching in elementary/secondary school(s)
    - ☐ A current cross-appointment in an elementary/secondary school
    - ☐ Answer differs by phase (please explain) ______________________________
    - ☐ Other (please specify) ______________________________

90. Which of the following are required of most mathematics **pedagogy** teaching staff in this route? (Check as many as apply.)
    - ☐ Bachelor's degree (ISCED level ______)
    - ☐ Master's degree (ISCED level ______)
    - ☐ Doctoral degree (ISCED level ______)
    - ☐ A teaching credential/qualification for elementary or secondary school
    - ☐ Experience teaching in elementary/secondary school(s)
    - ☐ A current cross-appointment in an elementary/secondary school
    - ☐ Answer differs by phase (please explain)
    - ☐ Other (please specify)

91. **Policy reform:** When was the last major policy change or reform in this route and why was this change undertaken?

Sources:

92. **Other contextual factors:** Are there other historical, social, or cultural factors that you think are essential for understanding of this route and which might be addressed in various ways later in the study? ___ yes ___ no

If yes, please summarize very briefly.

Sources:

93. **Problems:** Nationally, what are some of the main problems facing this route?

Sources:

94. **Other:** Please suggest other questions (and answers) that you think could help us to better understand this route, especially as they pertain to preparation to teach mathematics.

95. Have you filled in Section Three for each of the routes to be studied in TEDS-M?

____ Yes **Thank you. You have completed the Route Questionnaire.**

____ No **Please provide Section Three answers for each route until you have done all the routes to be studied by your country in TEDS-M.**

APPENDIX B:

TEDS-M Guidelines on Writing Country Reports

TEDS-M

COUNTRY REPORTS ON EDUCATION

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PREPARING COUNTRY REPORTS ON TEACHER EDUCATION: GUIDELINES FOR NATIONAL RESEARCH COORDINATORS

1.0 INTRODUCTION AND OVERVIEW

As part of Component 1 of the TEDS-M study, NRCs are asked to prepare a brief report describing the main features of mathematics teacher education in their country, with a focus on national policies and institutions (or state/provincial level policies in federal systems).

The country reports will be collected in the TEDS-M international report, elaborating upon and complementing the chapters reporting on cross-national analyses of data that NRCs provide by completing the TEDS-M route questionnaire.

Guidelines are provided below to assist NRCs in preparing their country reports. It is important that country reports reach the stage of being publishable. We hope that these guidelines will enable you to provide a coherent, well-organized account of recent history, current policies, and practices in your country. Although the guidelines are presented as a series of questions, we hope that you will feel encouraged to write your responses in a free-flowing, readable prose style that will lead to a country report that is publishable in the TEDS-M international report.

1.0.1 Structure of the Country Report

The report will fall into three main parts:

a) Context and organization of teacher education

b) Quality-assurance arrangements and program requirements

c) Funding and reform of teacher education

1.0.2 Context and Organization of Teacher Education

In this part you will be asked to elaborate on information which was provided in more standardized form on the route questionnaire. We also need to know more about the organization of the teaching career in general and implications for the organization of teacher education in particular. There are therefore three main sections to this part:

- Historical, cultural and social factors that have played a significant role in shaping the teacher education system
- Current policies and issues related to the teacher workforce, the teacher labor market, and teacher quality
- Structure and organization of the teacher education system.

1.0.3 Quality-Assurance Arrangements and Program Requirements

The purpose of this part of the report will be to provide readers with an understanding of national policies, institutions, and practices for monitoring and assuring the quality of teacher education and entrants to the teaching profession.

In broad terms, this section of the report will provide answers to three main questions:

Entry to teacher education: Who decides, and how, which students gain entry to teacher education programs? What policies and agencies are in place to monitor and assure the quality of entrants to teacher education?

Teacher education institutions: Who decides, and how, which institutions are allowed to train teachers? What policies and agencies are in place to monitor and assure the quality of teacher education institutions and programs?

Entry to the teaching profession: Who decides, and how, which students have met the requirements for full entry to the profession? What policies and agencies are in place to monitor and assure that graduates are competent and qualified to gain a license[1] to teach?

Each country will deal with these questions in their own way. Most countries have a government agency responsible for auditing the academic quality of their higher education institutions (the European Universities Association and the Asia-Pacific Quality Network are examples of associations of such agencies). These agencies are usually set up by national or state governments.

In addition, some countries also have government or professional agencies with more specific responsibilities for regulating the quality of *professional* preparation programs and the competence of their graduates. *These are the focus of our attention in this report.* These agencies may also be established by national or state governments, as statutory authorities, for example, or in some countries they may be set up by professional bodies. In some countries these agencies are known as "accreditation" agencies. Their function is to assess whether a professional preparation course, program, or institution meets specified standards and to approve those that do.

Accreditation is an endorsement by an independent, external agency that a program is able to produce graduates who are competent to begin practice and who meet standards for initial or provisional license. Accreditation agencies may be set up by governments (e.g., the General Teaching Council in Scotland), or they may be established by professional bodies themselves or not-for-profit private bodies (e.g., the National Council for Accreditation of Teacher Education in the USA). They may operate at the national level or the state/province level. They are usually also responsible for providing a license to beginning teachers who graduate from "accredited" professional programs.

In this section you will be asked about requirements set by quality-assurance agencies, if any, for the curriculum content and the practicum experience in teacher education programs. You will also be asked about the standards for exit from teacher education programs and entry to the profession for lower-secondary mathematics teachers and primary teachers.

1 According to the dictionaries a *license* is 1 a: permission to act b: freedom of action; 2 a: a permission granted by a competent authority to engage in a business or occupation or in an activity otherwise unlawful; b: a document, plate, or tag evidencing a license granted. In this document we use the word *license* to mean registration, certification or endorsement that a person has attained a level of knowledge and professional performance necessary to gain full entry to the teaching profession. Please use the term that your country uses to describe a teacher who has attained a level of knowledge and professional performance necessary to gain full entry to the teaching profession.

Various terms are used to refer to an endorsement that a *person* has attained a level of knowledge and professional performance necessary to gain full entry to the teaching profession. To avoid confusion throughout this document, we will use the term *license*; however please use the term that your country uses to describe a *teacher* who has attained a level of knowledge and professional performance necessary to gain full entry to the teaching profession. This endorsement may be given by a government agency (e.g., a statutory authority) or a professional body, often the same agency that is responsible for accreditation of teacher education programs.

A distinction may be made between standards for gaining a university teacher education *qualification* and standards for gaining a *license* to teach. Whereas a university determines whether an individual has met its academic qualification standards, in some countries another agency, such as a government employing authority or professional standards body, may determine whether to grant a license to teach.

In some countries gaining a university qualification automatically leads to gaining a license from a professional standards agency and eligibility to be employed as a teacher in schools. In others, national or state authorities may require graduates of teacher education programs to meet additional criteria they have set, such as national subject-matter knowledge tests, thesis completion, or successful completion of a period of induction or probationary teaching in schools.

We hope the detailed guidelines and questions below will assist NRCs to describe the way in which their country determines the requirements of teacher education programs and how it addresses the challenges of monitoring and assuring the quality of entrants to the profession.

1.0.4 Resources and Reforms in Teacher Education

To complete your country report, you will be asked to deal with two additional matters that will give readers insight into the nature of and prospects for change in your country. This part calls for analysis of the financing of teacher education, on the one hand, and the reform debates over teacher education, on the other.

1.0.5 Timeline

- Route questionnaire and guidelines for country report narrative to be sent to NRCs—February 2007
- NRCs submit route questionnaire and draft chapters in response to guidelines—15 May 2007
- Interaction as required between international centers and NRCs for editing of draft chapter and preparation of draft international report—May to August 2007
- Discuss draft country chapters and draft cross-national chapters at 3rd NRC meeting in June 2007
- Submission of draft international report to NSF as deliverable—1 Sept 2007
- Submission of draft international report to IEA Secretariat for editing and publishing—1 Sept 2007
- Publication and release of international report by IEA—Feb 2008

1.0.6 Style/Format

- Please use IEA style guidelines (enclosed in an attachment with this e-mail or via the TEDS-M website) and submit electronically as MS Word document if possible.

1.0.7 Total Desired Length

- 20–30 single-spaced, 12 point font pages.

2.0 CONTENT OF COUNTRY REPORT

Detailed Guidelines (Suggested Questions, Headings, and Lengths for Each Section)

Below you will find a set of questions to be answered in the country report. The questions are grouped by section with a suggested page length for each section. If the questions in the guidelines below do not apply in some way to your country, be clear in writing about this and stating why it is so. If you need to take some liberties with the sections, headings, and questions to accurately represent your country, this is permissible.

Throughout the report, please be clear about what is different and what is similar among:

- The various teacher education routes in your country
- Elementary vs. lower-secondary and upper-secondary levels
- States/provinces
- Public vs. private institutions.

For some sections you can draw heavily on material produced for other recent reports at the international (e.g., OECD and Eurydice) and national levels. Please be sure to give appropriate credit and to integrate the material effectively into the overall narrative.[2]

2.01 INTRODUCTION (1 page)

2.1 PART ONE: CONTEXT AND ORGANIZATION

2.1.1 Historical, Cultural, and/or Social Factors (2–3 pages)

Elaborate on Questions 91 and 92 in the route questionnaire concerning historical, social, or cultural factors that you think are essential for an understanding of these routes.

2 Please consult the following documents for general information about teacher education in your country:
1. The information network on education in *Europe, Eurydice* [mentioned on page 6 of this document]: http://www.eurydice.org/portal/page/portal/Eurydice
2. OECD's *Teachers Matter 2005* [mentioned on page 6 of this document] http://www.oecd.org/document/52/0,2340,en_2649_34859095_34991988_1_1_1_1,00.html
3. *Education at a Glance 2005* [mentioned on page 7 of this document]: http://www.oecd.org/document/34/0,2340,en_2649_34515_35289570_1_1_1_1,00.html
4. *Education at a Glance 2006* [mentioned on page 7 of this document]: http://www.oecd.org/document/52/0,2340,en_2649_34515_37328564_1_1_1_1,00.html
5. *Education at a Glance 2006*, list of tables [mentioned on page 7 of this document]: http://www.oecd.org/document/6/0,2340,en_2649_34515_37344774_1_1_1_1,00.html

2.1.2 Teaching Career, Teacher Labor Market, Teacher Working Conditions (3–4 pages)

a) How are teachers hired and promoted? Do they belong to a national service, i.e., is teaching a position-based or career-based occupation (as defined in OECD report *Teachers Matter*)? What proportions of teachers are employed in public and private schools?[3]

- Table 5.1 in the OECD's *Teachers Matter* (2005) summarizes the employment and dismissal conditions of teachers in public schools, 2004. Could countries that took part in the OECD project update the table, and other countries complete the table? How do these conditions differ for teachers in private schools (if present)?
- Table 5.2 in the OECD's *Teachers Matter* (2005) summarizes the teacher recruitment procedures and selection criteria in public schools, 2004. Could countries that took part in the OECD project update the table, and other countries complete the table? How do these procedures and criteria differ for teachers in private schools (if present)?

b) How specialized are teachers? What grades, subjects, and types of schools are they prepared and assigned to teach for?

c) What are the particular challenges in the working conditions for which teachers must be prepared (e.g., large classes, lack of materials, long hours, remote locations)?

d) Is there a shortage or excess of primary school teachers and/or mathematics teachers in lower-secondary school? (A "shortage" may be indicated by unfilled vacancies, "difficult to fill" vacancies, and/or "out of field" teaching; i.e., teachers who are not appropriately qualified to teach mathematics.) Why does this situation exist?

e) How competitive is teaching with other occupations in terms of salary, working conditions, etc? (Countries could also update or complete Table D3.1 on teachers' salaries 2004 in the OECD's *Education at a Glance* 2006.)

2.1.3 Structure and Organization of Teacher Education (2–3 pages)

a) Who provides teacher education for future primary and secondary teachers? How many providers/institutions are there? What kinds of programs do they offer? How many teacher education programs are there? How many students in each program?

b) Routes to be studied in TEDS-M—for each country, summarize the information provided in the route questionnaire (Questions 15–34 for concurrent routes, 35–61 for consecutive routes, and 62–72 for primarily practice (apprenticeship) routes)

c) Routes not studied in TEDS-M (as identified on the frame questionnaire) and why not studied

3 The OECD's *Education at a Glance* glossary defines these terms as follows. A school is classified as public if it is controlled and managed directly by a public education authority or agency; or is controlled and managed either by a government agency directly or by a governing body (council, committee etc.), most of whose members are appointed by a public authority or elected by public franchise. A school is classified as private if it is controlled and managed by a non-governmental organization (e.g., a church or business enterprise), or if its governing board consists mostly of members not selected by a public agency.)

2.2 PART TWO—QUALITY ASSURANCE ARRANGEMENTS AND PROGRAM REQUIREMENTS

2.2.1 Entry Standards/Selection (2–3 pages)

We are interested in understanding national policies and practices in each participating country for monitoring and assuring the quality of teacher education programs, institutions, and the quality of graduate teachers from those programs.[4] (In countries with federal systems, the relevant policies may be formed at the state, province, or land government level.)

a) Who determines the total number of university places available for teacher education students?

b) How, or on what basis, is the total number of places available for teacher education students determined?

c) Who determines the requirements or standards for students to gain entry to professional preparation programs for teachers?

d) What are the standards or requirements to be eligible to enter programs for preparing teachers of mathematics at the *lower-secondary level*? e.g.,
   - What level of secondary school and/or university mathematics courses is required?
   - Are there any areas of content or subject matter in previous secondary school/university mathematics courses that are prescribed or required?
   - Are there any tests of pre-requisite subject-matter knowledge that must be taken or passed?

e) What are the standards or requirements to be eligible to enter programs for preparing teachers who will teach mathematics at the *primary/elementary level*? (For example, what level of secondary school/university mathematics courses is required? Are there pre-requisite subjects that must have been taken?)

h) How does the responsible agency ensure that its selection standards are complied with?

i) How do the academic standards of entrants to teacher education programs for teachers of mathematics at the *lower-secondary level* compare with standards for entry to most other mathematics-related professional preparation programs? (Please refer to the quality indicators that are used in your country: e.g., SAT scores in the US; "A" levels in England, etc.)

j) How do the academic standards of entrants to teacher education programs for teachers of mathematics at the *primary/elementary* and *secondary level* compare with standards for entry to most other university or professional preparation programs?

k) If any other external examinations are required at some point during these routes, what are the purpose, nature, content, and use of these examinations?

4 The term "program" as used here refers to the total set of courses, units of study, modules, activities, and school experience that a future teacher must complete successfully to gain the status of a qualified and licensed (registered, certified) teacher.

2.2.2 Accreditation Systems for Teacher Education (2–3 pages)

The following set of questions focuses on agencies responsible for quality assurance and certification of teacher education programs in your country, as related to the preparation of teachers who will teach *mathematics at lower-secondary and primary school levels.*

a) What is the process for developing or revising teacher education routes/programs in your country? For example, who develops routes/programs and who has to approve them? Are there national/state guidelines about the content of routes/programs? What do these guidelines contain?

b) Is there an agency or authority (or authorities) responsible for the approval or accreditation of teacher education institutions or programs in your country (e.g., national and/or state governments, national or state/provincial statutory authorities, professional or independent/voluntary bodies)? If more than one, what aspects of accreditation does each authority control? (Please give the full name/s of the agency/ies and their English translation.)

c) What is the composition of the governing board of this agency? (For example, how many practicing teachers, teacher educators, etc are on the board?)

d) What criteria, standards, or requirements does the accreditation agency set for accreditation, particularly with respect to the preparation of

   (i) Future teachers of lower-secondary school mathematics and

   (ii) Future primary teachers?

These might include criteria for course content, nature and level of mathematics, amount of school experience, among others.

e) In brief, how does this accreditation body carry out its accreditation function to determine whether the criteria have been met? What evidence and procedures does this agency use in assessing and accrediting the quality of teacher education institutions or programs (e.g., student intake quality; documentation about courses, staff, resources; visitation teams; quality of outcomes as measured by surveys of "clients" such as students, school principals, and employing authorities, etc.)?

f) Do all teacher education institutions or programs have to be accredited? How frequently are teacher education institutions or programs reviewed for accreditation (e.g., once every five years)? How many institutions have been denied accreditation over the past ten years?

2.2.3 Curriculum Requirements (2–3 pages)

In this section, you should elaborate on all relevant questions in the route questionnaire, and whatever else you consider relevant, in order to answer the following general questions:

a) How is the curriculum content of the programs set and by whom?

b) What are the national or state/provincial curriculum requirements (whether they apply to all routes or to particular routes)?

2.2.4 Practicum and Field Experience Requirements (1 page)

Summarize from the content in Questions 84–87 in the route questionnaire.

2.2.5 Staffing Requirements (1 page)

Summarize any national qualifications required for the staffing of instructors/faculty members within the institutions of the routes being studied.

2.2.6 Standards and Requirements for Entry to the Teaching Profession (2–3 pages)

The general question for this section is, "W

2.3.2 Public Debates Concerning Reform of Teacher Education (2–3 pages)

What if anything about these national policies regarding mathematics teacher education are matters of strong public debate and why?

APPENDICES

Appendix A: Summary of Additional Insightful National Statistics
Select statistics that are readily available at the national level on the characteristics of teacher education programs.

Appendix B: Bibliographical References of Important Studies Concerning any of the Routes in Question
Please provide English translations for the titles of the references.

Appendix C: Biosketches for Authors of this Chapter at NRC
Two hundred words per author.

APPENDIX C:

Characteristics of National Samples: Implementations of the International Sampling Design in Participating Countries

Sabine Meinck, ***IEA Data Processing and Research Center***

Jean Dumais, ***Statistics Canada***

Introduction: How to Read this Appendix

This appendix details how the international sampling plan was implemented in each participating country. It will help readers of the TEDS-M international report (Tatto et al., 2012) or researchers interested in carrying out secondary analysis of the TEDS-M international database to understand how the target populations were defined, what the specific characteristics of the particular samples were, and how the data were collected. With this knowledge, the audience will be able to embed all findings into correct contexts.

The sections of this appendix are written in a systematic way. This introductory section presents key terms and concepts so that readers can correctly interpret the text and tables in the following country-specific sections.

Key Terms and Concepts Used in the Country-Specific Sections

- *Sample design:* All country-specific details concerning the sample design such as sample sizes, stratification (if used), sampling method (simple random sampling versus sampling with selection probabilities proportional to size), and specific strategies for within-institution sampling (if deviating from the standard design) are explicated in this segment of each country section.
- *Total number of TEDS-eligible institutions:* This refers to the total number of institutions offering teacher education to targeted future teachers in the country. These institutions constituted the sampling frame.
- *Coverage:* Any parts of the targeted populations not covered by the assessment are given and described in this segment. Note that reduced coverage is also annotated in the international report. In most countries, however, 100 percent of the targeted populations were covered.
- *Exclusions:* This segment of the country sections presents and describes any parts of the targeted populations that were excluded from an assessment. Exclusions of future teachers had to be kept below five percent. Exclusion rates above this percentage are annotated in the international report.
- *Particularities:* Any specific feature of the population that had an influence on the sample implementation is given here. Particular attention is given to program-types producing teachers eligible to teach both primary and lower-secondary students. Deviations from the international sampling plan are also described.

- *Exhibit titled "Explicit stratification and sample allocation":* This table is provided in those instances where an institution sample was selected and explicit stratification used. It gives the stratum names, stratum sizes, and the allocation of the sample to the strata.
- *Exhibit titled "Sample design (institution and future teacher surveys)":* This table displays the structure and size of the institution and future teacher samples as well as the structure and size of the populations, estimated using sample data. This table is always separated into displays for the two future teacher target populations (i.e., primary and lower secondary). The program-types defined by each participating country are listed according to the level for which they were preparing future teachers. If a program-type was preparing future teachers for both levels (primary and lower secondary), it is listed in both table sections; a footnote points the reader to this particularity. The columns dedicated to institutions give:

  a) A sample estimate of the number of institutions providing a specific program-type in a country[1] and the total number of institutions offering education for the specific level;[2]

  b) The number of institutions that participated in the future teacher surveys;

  c) The number of institutions that completed an institutional program questionnaire (IPQ) for the particular program.

  The columns dedicated to future teachers give:

  d) A sample estimate of the number of future teachers of a particular program-type in a country[3] and an estimated total number of future teachers belonging to the specific level (primary, lower secondary);[4]

  e) The number of participating future teachers per program-type and in total for the particular level.

- *Exhibit titled "Mapping program-types to groups defined for reporting purposes":* Because the program-types specified in each country may have had meaning only to persons familiar with the particular education system, TEDS-M built, for reporting purposes, groups of programs that shared common features across countries. The categorization was based on (i) the degree of specialization, and (ii) the grade ranges for which future teachers were being prepared to teach. The program-groups eventuating from this process were the following:

  – **PRIMARY LEVEL:**
  Lower-primary generalist (to Grade 4 maximum)
  Primary generalist (to Grade 6 maximum)
  Primary/lower-secondary generalist (to Grade 10 maximum)
  Primary mathematics specialist.

1 This number is equal to the sum of the final TPU weights for this program-type.
2 This number is equal to the sum of the final TPU weight for all programs eligible for one particular level.
3 This number is equal to the sum of the final future teacher weights for this program-type.
4 This number is equal to the sum of the final future teacher weight for all programs eligible for one particular level.

– **LOWER-SECONDARY LEVEL:**
  Lower-secondary mathematics (to Grade 10 maximum)
  Lower-secondary mathematics (to Grade 11 and above).

The table maps the program-types specified in each country to the groups that were defined for reporting purposes. Program-types preparing future teachers to teach both primary and lower-secondary students were allocated to one group in both levels.

- *Exhibit titled "Sample design (educator survey)":* In this table, the structure and size of the educator sample is displayed as are the structure and the size of the educator population, estimated using sample data. The table is separated by the three educator-groups that were defined for sampling purposes. The table also gives the number of participants as well as the estimated number of educators per group[5] and in total[6] in the population.

5 This number is equal to the sum of the final educator weight for all educators belonging to one group.
6 This number is equal to the total sum of the final educator weight.

1. BOTSWANA

Sample design:	Census of institutions, educators, and future teachers.
Total number of TEDS-eligible institutions:	Seven.
Coverage:	One hundred percent in all target populations.
Exclusions:	None.
Particularities:	Very small target populations.

Exhibit C1.1. Sample design in Botswana (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs**	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Diploma in Primary Education	4	4	4	100	86
Total	**1**		**4**	**4**	**4**	**100**	**86**
Level: Lower secondary							
Concurrent	2	Bachelor of Education	2	2	2	25	19
	3	Diploma in Secondary Education	1	1	1	35	34
Total	**2**		**3**	**3**	**3**	**60**	**53**

Note: *IPQ = institutional program questionnaire.

Exhibit C1.2: Mapping program-types to groups defined for reporting purposes (Botswana)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Diploma in Primary Education	Primary/Lower-secondary generalist (Grade 10 maximum)	–
Bachelor of Education	–	Upper-secondary mathematics (to Grade 11 and above)
Diploma in Secondary Education	–	Lower-secondary mathematics (to Grade 10 maximum)

*Exhibit C1.3: Sample design in Botswana (educator survey)**

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	16	16
General pedagogy educators	28	27
Educators of mathematics and of mathematics pedagogy and general pedagogy	0	0
Total	**44**	**43**

Note: * Number of institutions participating in educator survey: seven.

2. CANADA (FOUR PROVINCES)

Sample design:	Census of institutions and educators; sample of future teachers within large institutions according to the international sampling plan.
Total number of TEDS-eligible institutions:	Thirty.
Coverage:	One hundred percent in the four participating provinces: Ontario, Québec, Nova Scotia, and Newfoundland and Labrador.
Exclusions:	None.
Particularities:	Because of extremely low participation rates in all target populations, data for Canada (four provinces) were not weighted, program-types were not mapped to groups for reporting purposes, and results were not reported together with data from other participating countries.

Exhibit C2.1: Sample design in Canada, four provinces (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Bachelor of Arts/ Bachelor of Science and Bachelor of Education, Primary (five years)	8	0	2	–	0
	2	Bachelor of Education, Primary/Elementary (five years)	1	1	1	***	16
	3	Bachelor of Education, Primary (four years)	11	1	3	***	20
Consecutive	4	Bachelor of Education, Primary (one year)	12	0	4	–	0
	5	Bachelor of Education, Primary (two years)	4	0	2	–	0
Concurrent	*	Bachelor of Arts and Bachelor of Education, Primary (four years)	1	0	0	–	0
	*	Bachelor of Arts (Education), Primary (three years)	1	0	0	–	0
Total	**7**		**28****	**2**	**12**	*****	**36**

Table continued on next page

Exhibit C2.1: Sample design in Canada, four provinces (institution and future teacher surveys) (contd.)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Lower secondary							
Concurrent	6	Bachelor of Arts/Bachelor of Science and Bachelor of Education, Secondary (five years)	9	2	2	***	31
	7	Bachelor of Education, Secondary Mathematics (four years)	10	2	2	***	10
Consecutive	8	Bachelor of Education, Secondary (one year)	12	4	5	***	61
	9	Bachelor of Education, Secondary (two years)	4	2	2	***	23
Concurrent	*	Bachelor of Arts (Education), Secondary (three years)	1	0	0	–	0
	*	Bachelor of Education, Secondary (four years)	1	0	0	–	0
	*	Bachelor of Science and Bachelor of Education, Secondary (four years)	2	0	0	–	0
Consecutive	*	Bachelor of Education, Secondary (one and half years)	1	0	0	–	0
Total	**8**		**28****	**8****	**11**	*******	**125**

Notes:
* No number was assigned because no future teachers or educators from this program participated.
** The numbers in the column do not add up to the total because some institutions were offering more than one program.
***Data remained unweighted; estimates of population totals cannot be given.

Exhibit C2.2: Sample design in Canada, four provinces (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	*	35
General pedagogy educators	*	37
Educators of mathematics and mathematics pedagogy and general pedagogy	*	2
Total	*****	**74**

Notes:
Number of institutions participating in educator survey: 10.
*Data remained unweighted; estimates of population totals cannot be given.

3. CHILE

Sample design:	Census of institutions, future teachers, and educators.
Total number of TEDS-eligible institutions:	Forty.
Coverage:	One hundred percent in all target populations.
Exclusions:	One institution was excluded because its future teachers were on practicum in remote areas of the country at the time of the assessments. This omission led to exclusion rates of 2.0 percent of institutions, about 2.0 percent of educators, 3.8 percent of future primary teachers, and 3.6 percent of future lower-secondary teachers.
Particularities:	Future teachers following the program-type generalists (Grades 1 to 8) were being prepared to teach mathematics to primary and lower-secondary students. They were therefore considered to be eligible for both future teacher target populations. Because both assessment booklet types (primary booklets and lower-secondary booklets) were distributed evenly among future teachers from that program-type, this program-type appears twice in Exhibit C3.1. Note that only one institutional program questionnaire was completed for each teacher preparation unit belonging to this program-type. On the original list of institutions, 50 institutions were listed. Fourteen were deemed ineligible for the primary level, and 10 were deemed ineligible for the secondary level (because there were no future teachers in their final year). The exclusion rates, however, were calculated on the basis of the original figures.

Exhibit C3.1: Sample design in Chile (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Generalists (Grades 1 to 8)	36	31	31	2,018	657
Total	**1**		**36**	**31**	**31**	**2,018**	**657**
Level: Lower secondary							
Concurrent	2	Generalists (Grades 1 to 8)	34	28	**	2,061	648
	3	Generalists with further mathematics education (Grades 5 to 8)	11	9	7	181	98
Total	**2**		**40***	**33***	**38**	**2,242**	**746**

Notes:
* The numbers in the column do not add up to the total because some institutions were offering both programs.
** Identical to the corresponding entries in the part of the table dedicated to the primary level.

Exhibit C3.2: Mapping program-types to groups defined for reporting purposes (Chile)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Generalists (Grades 1 to 8)	Primary/Lower-secondary generalist (Grade 10 maximum)	Lower-secondary mathematics (to Grade 10 maximum)
Generalists with further mathematics (Grades 5 to 8)	–	Lower-secondary mathematics education (to Grade 10 maximum)

Exhibit C3.3: Sample design in Chile (educator survey)

Institutions participating in the educator survey:	**28**

4. CHINESE TAIPEI

Introductory Note

In deviation from the international sample design, the samples of institutions in Chinese Taipei were customized to the needs of each of the four TEDS-M surveys. Therefore, the strategies used to select the institutions as primary sampling units were reported separately for these different surveys.

Future Teacher Surveys

Sample design—survey of future primary teachers:	The sample of institutions was stratified by size (refer to Exhibit C4.1). Large institutions (more than 75 future primary teachers in their final year) were selected with certainty. From the small institutions stratum, two institutions were selected with equal probability. Within selected institutions, all or at least 7 to 10 session groups (building a sample of at least 90 future teachers) were selected. Within selected session groups, all future teachers were asked to participate in the survey.
Sample design—survey of future lower-secondary teachers:	Census of institutions and future teachers.
Total number of TEDS-eligible institutions:	Forty-six.
Coverage:	One hundred percent in both future teacher target populations.
Exclusions:	Very small institutions (fewer than 26 future primary teachers or fewer than five future lower-secondary teachers, respectively, in their final year) were excluded. This omission led to exclusion rates of 4.5 percent for future primary teachers and 4.7 percent for future lower-secondary teachers, respectively.

Exhibit C4.1: Explicit stratification and sample allocation in Chinese Taipei (future primary teacher survey)

Explicit Stratum	No.	Stratum Size*		Sample Size**	
		Institutions	*Future teachers*	*Institutions*	*Future teachers*
Small institutions	1	8	323	2	62
Large institutions, selected with certainty	2	9	3,622	9	861
Total	**2**	**17**	**3,945**	**11**	**923**

Notes:
* As estimated on the sampling frame, after exclusion.
** Participants in future teacher survey.

Exhibit C4.2: Sample design in Chinese Taipei (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers	
			Population (sample estimate)	*Participants (future teacher surveys)*	*Population (sample estimate)*	*Participants*
Level: Primary						
Concurrent	1	Elementary teacher education	18	11	3,595	923
Total	**1**		**18**	**11**	**3,595**	**923**
Level: Lower secondary						
Concurrent	2	Secondary mathematics teacher education	19	19	375	365
Total	**1**		**19**	**19**	**375**	**365**

Exhibit C4.3: Mapping program-types to groups defined for reporting purposes (Chinese Taipei)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Elementary teacher education	Primary generalist (Grade 6 maximum)	–
Secondary mathematics teacher education	–	Upper-secondary mathematics (to Grade 11 and above)

Educator and Institution Surveys

Sample design:	The sample of institutions was stratified by size (refer to Exhibit C4.3). Large institutions (more than 75 future primary teachers and more than 13 future lower-secondary teachers in their final year, respectively) were selected with certainty. From the small institutions stratum, two institutions were selected per level with equal selection probability.
Total number of TEDS-eligible institutions:	Forty-six.
Coverage:	One hundred percent.
Exclusions:	Very small institutions (fewer than 26 future primary teachers and fewer than five future lower-secondary teachers, respectively, in their final year per institution) were excluded. This omission led to an exclusion rate of 26.1 percent of institutions but of less than 3.5 percent of the educator population.
Completion of IPQ:	All institutions selected for the educator survey completed this survey instrument. Eleven IPQs were received from primary teacher education programs. Eight IPQs were received from secondary mathematics teacher education programs.
Particularities:	Because of the elective character of general pedagogy courses in Chinese Taipei, the number of TEDS-M eligible general pedagogy educators was, in comparison to the numbers in other participating countries, small. Because the number of sampled institutions selected for the educator survey and the institutional program survey was smaller than the number of institutions selected for the future lower-secondary teacher survey, no educator and program information was available for most of the small institutions offering education to future lower-secondary teachers.

Exhibit C.4.4: Explicit stratification and sample allocation in Chinese Taipei (educator and institution surveys)

Explicit Stratum	No.	Stratum Size*		Sample Size**	
		Institutions	*Future teachers*	*Institutions*	*Future teachers*
Institutions offering education to future primary teachers					
Small institutions	1	8	323	2	7
Large institutions, selected with certainty	2	9	3,622	9	108
Total	**2**	**17**	**3,945**	**11**	**115**
Institutions offering education to future lower-secondary teachers					
Small institutions	1	15	143	2	16
Large institutions, selected with certainty	2	6	301	6	64
Total	**2**	**21**	**444**	**8**	**80**

Notes:
* As estimated on the sampling frame, after exclusion.
** Participants in future teacher survey.

Exhibit C4.5: Sample design in Chinese Taipei (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	137	85
General pedagogy educators	200	108
Educators of mathematics and mathematics pedagogy and general pedagogy	2	2
Total	**339**	**195**

Note: Number of institutions participating in educator survey: 19.

5. GEORGIA

Sample design:	Census of institutions, educators, and future teachers.
Total number of TEDS-eligible institutions:	Ten.
Coverage:	One hundred percent in all targeted populations.
Exclusions:	Sectors of institutions with Russian and Azeri as languages of instruction were excluded, leading to exclusion rates of 1.4 percent of future primary teachers and 1.7 percent of future lower-secondary teachers, respectively.
Particularities:	The target population of future lower-secondary teachers was very small.

Exhibit 5C.1: Sample design in Georgia (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Bachelor in Pedagogy (four years)	9	9	9	636	485
	2	Bachelor in Pedagogy (five years)	1	1	1	23	21
Total	**2**		**9***	**9***	**10**	**659**	**506**
Level: Lower secondary							
Concurrent	3	Bachelor in Mathematics	5	5	5	99	69
	4	Master's in Mathematics	2	2	2	17	9
Total	**2**		**6***	**6***	**7**	**116**	**78**

Note: *The numbers in the column do not add up to the total because some institutions were offering more than one program.

Exhibit C5.2: Mapping program-types to groups defined for reporting purposes (Georgia)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Bachelor in Pedagogy (four years)	Lower-primary generalist (Grade 4 maximum)	–
Bachelor in Pedagogy (five years)	Lower-primary generalist	–
Bachelor in Mathematics	–	Upper-secondary mathematics (to Grade 11 and above)
Master's in Mathematics	–	Upper-secondary mathematics (to Grade 11 and above)

Exhibit C5.3: Sample design in Georgia (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	42	41
General pedagogy educators	20	20
Educators of mathematics and mathematics pedagogy and general pedagogy	2	1
Total	**64**	**62**

Note: Number of institutions participating in educator survey: 10.

6. GERMANY

Introductory Note

Applying the international sampling design and the TEDS-M definitions to the system of future teacher education in Germany was a particular challenge. Some background information on the structure of this system is essential in terms of understanding the modalities of and adaptations to the international sampling plan and TEDS-M definitions that were needed in order to implement the study successfully in Germany. Because the description of the system given here has been kept to a minimum, please refer to the section describing Germany's teacher education system in the international report (Tatto et al., 2012) for more detailed information.

Teacher education in Germany is organized in two consecutive phases. The first phase is carried out at universities or teacher training colleges (*Pädagogische Hochschule*). Its duration is 3.5 to 4.5 years, and it focuses primarily on the transfer of theoretical knowledge. The second phase, lasting from 1.5 to 2.0 years, is carried out at *Studienseminare* or *Ausbildungsschulen*, which are relatively small units of teacher training. The focus of this second phase is primarily on the practice-oriented aspects of preparing for the teaching profession. Because every future teacher has to pass successfully through both phases before becoming a certified teacher, the future teachers targeted by TEDS-M (i.e., in their final year) could be found only in facilities offering the second phase of teacher training.

It is also important to understand that there is no direct link between institutions offering the first phase of education and those offering the second phase. This means that future teachers coming from one specific university can be found at any *Studienseminar* across the country. Completion of the first phase is awarded with a separate university degree, but this does not qualify an individual to teach at schools. What this means with respect to the classification of teacher education programs is that German teacher education must be regarded as consecutive even when parts of the professional training happen during the first phase.

The ministries of education in each of Germany's federal states provide teacher education institutions with comprehensive instructions on the curriculum and modalities of future teacher education within the respective state, an occurrence which is especially valid for the second phase of teacher education. For this reason, TEDS-M considered the administrative units of the educational ministries of the federal states to be "institutions" in the sense of the TEDS-M definition. TEDS-M considered an expert panel, which included personnel from the respective educational ministry and personnel from universities or teacher training colleges within the federal state, to be the appropriate respondent to complete the institutional program questionnaires.

Although future teachers eligible for TEDS-M could be found only in the second-phase facilities, TEDS-eligible educators could be found in both types of institutions, that is, facilities offering the first or the second phase of teacher education. In fact, educators teaching mathematics could be found only in the first-phase facilities. To make the German educator population comparable to the one defined at the international level, all TEDS-eligible educators—no matter whether they were teaching in the first or the second phase—needed to have a positive selection probability. Implementation of the same approach used in the future teacher and institutional surveys (federal states = institutions) would have necessitated listing all TEDS-eligible educators per federal state. Alternatively, because all federal states were asked to participate, it could have meant compiling a comprehensive list of all educators in Germany.

These approaches turned out to be practically impossible. As such, it was necessary to implement another two-stage sampling algorithm in order to select individuals for this part of the survey (for more details, see Section 6.4 in Chapter 6). The "institutions" that served as primary sampling units were now defined as the facilities offering the actual education (i.e., universities, teacher education colleges, *Studienseminare*, *Ausbildungsschulen*).

Due to the structure of the sample (and the German system of teacher education), there could be no linkage between the data collected from the populations of educators and the populations of future teachers.

Future Teacher Survey and Institution Surveys

Sample design:	All 16 federal states were asked to participate in the study. Due to the specific institution definition for these parts of the assessment (see introductory note above), the design was equivalent to a census of institutions in the other TEDS-M participating countries. For simplicity, the term "institutions" used here always refers to the administrative units of the educational ministries of the federal states. Future teachers in Germany who fitted the TEDS-M target population definition were allocated to six specific program-types: • Primary with focus on mathematics (Type 1a) • Primary without focus on mathematics (Type 1b) • Primary and Secondary I with focus on mathematics (Type 2a) • Primary and Secondary I without focus on mathematics (Type 2b) • Secondary I with focus on mathematics (Type 3) • Secondary II with focus on mathematics (Type 4). As stated in the introductory note, all eligible future teachers could be found in the second-phase institutions (*Studienseminare*, *Ausbildungsschulen*). Future teachers belonging to different program-types could be found within these facilities. For example, in one *Studienseminar*, there were four future teachers in Program-Type 2a and 12 future teachers in Program-Type 3. In order to control the selection probabilities of future teachers belonging to the different types, the TEDS-M sampling team split the future teachers within the second-phase institutions into clusters, with the future teachers in each cluster belonging to a program-type that differed from the types in the other clusters. These clusters thus contained mutually exclusive and exhaustive groups of future teachers, each belonging to one program-type. They served as the secondary sampling units. The goal of the sampling plan was to achieve a sample that represented the German population of TEDS-eligible future teachers within institutions and program-types in fairly even proportions. That meant taking each institution and then selecting a predefined number of clusters from each program-type, while simultaneously taking into account the varying number and size of the clusters within the institutions. All future teachers belonging to one cluster were asked to participate, and all selection procedures were in line with the international sampling design. During TEDS-M, a randomized preselection of clusters for another ongoing national survey in Germany (CoActiv) took place in one institution (federal state). The IEA DPC selected a simple random sample of 11 Program-Type 3 clusters and 15 Program-Type 4 clusters for CoActiv from this institution in order to avoid any overlap between the CoActiv and TEDS-M surveys. The TEDS-M cluster sample was then selected out of the remaining nonsampled clusters.

	In Germany, future teachers following the program-type *Primary and Secondary I with focus on mathematics* (Type 2a) are prepared to teach mathematics to both primary and lower-secondary students. TEDS-M therefore considered these future teachers to be eligible for both future teacher target populations. Both survey booklet types (i.e., the primary booklets and the lower-secondary booklets) were distributed evenly among the future teachers from that program-type. This program-type therefore appears twice in Exhibit C6.1. Note, however, that only one institutional program questionnaire per federal state was completed for each teacher preparation unit belonging to this program-type.
Total number of TEDS-eligible institutions:	Sixteen.
Coverage:	One hundred percent in all target populations.
Exclusions:	Second-phase facilities (*Studienseminare*, *Ausbildungsschulen*) with fewer than four future teachers in total were excluded prior to sampling. In addition, one small institution (federal state) was excluded from both future teacher surveys because it had very few future teachers within the scope of TEDS-M. This omission led to an exclusion rate of 3.7 percent of future primary teachers and 5.6 percent of future lower-secondary teachers.

Exhibit C6.1: Sample design in Germany (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Primary with focus on mathematics (Type 1a)	7	7	7	1,286	360
	2	Primary without focus on mathematics (Type 1b)	4	4	4	1,430	162
	3	Primary and Secondary I with focus on mathematics (Type 2a)	7	7	8	1,093	97
	4	Primary and Secondary I without focus on mathematics (Type 2b)	7	6	8	2,433	413
Total	**4**		**15***	**14***	**27**	**6,242**	**1,032**
Level: Lower secondary							
Consecutive	3	Primary and Secondary I with focus on mathematics (Type 2a)	**	**	**	1,021	87
	5	Secondary I with focus on mathematics (Type 3)	9	9	11	1,162	321
	6	Secondary II with focus on mathematics (Type 4)	12	12	13	1,200	363
Total	**3**		**13***	**13***	**32**	**3,383**	**771**

Notes:

* The numbers in the column do not add up to the total since some "institutions" were offering more than one program.

** Identical to the corresponding entries in the part of the table dedicated to the primary level.

Exhibit C6.2: Mapping program-types to groups defined for reporting purposes (Germany)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Primary with focus on mathematics (Type 1a)	Lower-primary generalist (Grade 4 maximum)	–
Primary without focus on mathematics (Type 1b)	Lower-primary generalist (Grade 4 maximum)	–
Primary and Secondary I with focus on mathematics (Type 2a)	Primary mathematics specialist	Lower-secondary mathematics (to Grade 10 maximum)
Primary and Secondary I without focus on mathematics (Type 2b)	Lower-primary generalist (Grade 4 maximum)	–
Secondary I with focus on mathematics (Type 3)	–	Lower-secondary mathematics (to Grade 10 maximum)
Secondary II with focus on mathematics as (Type 4)	–	Upper-secondary mathematics (to Grade 11 and above)

Educator Survey

Sample design:

In conformity with the international sampling plan, TEDS-M implemented a two-stage sampling design for the German educator survey. All first- or second-phase facilities offering teacher education (universities, teacher education colleges, *Studienseminare*, *Ausbildungsschulen*) were considered to be primary sampling units. For simplicity, these facilities are referred to as institutions in the following explanation.

In order to accommodate the different structures and sizes of institutions offering the first or second phase of future teacher training, the TEDS-M sampling team explicitly stratified the sample into three different strata (see also Exhibit C6.3).

- The first stratum contained all institutions offering first-phase education.
- The second stratum contained two second-phase institutions that were relatively large. Both were selected with certainty.
- The third stratum contained all remaining second-phase institutions. Within this third stratum, a two-phase sample was selected in order to accommodate a special request from the TEDS-M national study center.

In each stratum, a simple random sample of institutions was selected. Within almost all selected institutions, all TEDS eligible educators were asked to participate in the survey. In a few large institutions, a subsample of educators was selected.

The sample was furthermore implicitly stratified by federal states to ensure a fair allocation of the sample across the country.

Total number of TEDS-eligible institutions: Three hundred and eighty-two.

Coverage: One hundred percent.

Exclusions: Second-phase facilities (*Studienseminare*, *Ausbildungsschulen*) with fewer than four future teachers in total were excluded prior to sampling. This omission led to an exclusion rate of 27 percent for the second-phase institutions. The exclusion rate of educators, however, was estimated as being below two percent overall.

Exhibit C6.3: Explicit stratification and sample allocation in Germany (educator survey)

Explicit Stratum	No.	Stratum Size*	Sample Size**	
		Institutions	*Institutions*	*Educators*
Phase 1	1	70	31	371
Phase 2—certainty institutions	2	2	1	10
Phase 2—non-certainty institutions	3	226	14	101
Total	**3**	**298**	**46**	**482**

Notes:
* As estimated on the sampling frame, after exclusions.
** Participants.

Exhibit C6.4: Sample design in Germany (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	476	115
General pedagogy educators	2,444	225
Educators of mathematics and mathematics pedagogy and general pedagogy	1,022	142
Total	**3,944**	**482**

Note: Number of institutions participating in educator survey: 46.

7. MALAYSIA

Sample design:	Census of institutions and samples of educators and future teachers within large institutions according to the international sampling plan.
Total number of:	
TEDS-eligible institutions	Thirty.
Coverage:	The program-type *Bachelor of Education in Teaching of English as a Second Language with minor in mathematics* offered by one institution was not covered. Future teachers in that program-type, however, would have been eligible for the primary population. A reduced coverage of 3.4 percent of institutions offering education to future primary teachers was the consequence. The respective percentage of under-coverage for future primary teachers was estimated as being below 5.0 percent.
Exclusions:	None.
Particularities:	The program-type *Post-Graduate Diploma of Education (Mathematics)*, offered by two institutions, had no future teachers in the final year and was therefore not eligible for the TEDS-M survey.

Exhibit C7.1: Sample design in Malaysia (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Malaysian Teaching Diploma (Mathematics)	22	21	9	558	512
	2	Bachelor of Education in Primary Education	1	1	1	19	17
	3	Diploma of Education (Mathematics)	2	2	2	50	47
Total	**3**		**24***	**23**	**12**	**627**	**576**
Level: Lower secondary							
Consecutive	4	Bachelor of Education (Mathematics), Secondary	1	1	2	82	43
	5	Bachelor of Science with Education (Mathematics), Secondary	6	5	6	521	346
Total	**2**		**7**	**6**	**8**	**603**	**389**

Note: *The numbers in the column do not add up to the total because some institutions were offering more than one program.

Exhibit C7.2: Mapping program-types to groups defined for reporting purposes (Malaysia)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Malaysian Teaching Diploma (Mathematics)	Primary mathematics specialist	–
Bachelor of Education in Primary Education	Primary mathematics specialist	–
Diploma of Education (Mathematics)	Primary mathematics specialist	–
Bachelor Education (Mathematics), Secondary	–	Upper-secondary mathematics (to Grade 11 and above)
Bachelor of Science with Education (Mathematics), Secondary	–	Upper-secondary mathematics (to Grade 11 and above)

Exhibit C7.3: Sample design in Malaysia (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	270	165
General pedagogy educators	61	21
Educators of mathematics and mathematics pedagogy and general pedagogy	126	69
Total	**457**	**255**

Note: Number of institutions participating in educator survey: 22.

8. NORWAY

Sample design:	Census of institutions and future teachers.
Total number of TEDS-eligible institutions:	Forty-five.
Coverage:	One hundred percent in the target populations of institutions and future teachers.
Exclusions:	None.
Particularities:	Faculties at universities offering specific program-types were considered to be institutions in the sense of the TEDS-M definition. Because the individuals pertaining to program-types *ALU—general teachers for primary and lower secondary, ALU—general teachers for primary and lower-secondary school with special program for mathematics*, and *Master's—teachers in lower- and higher-secondary school* were partly overlapping, analysis across these program-types was inappropriate. TEDS-M therefore strongly recommends that researchers conduct analyses separately for each program-type. Although conducting a census of institutions, TEDS-M calculated the nonresponse adjustment of institutions within program-types. Future teachers from one program-type (*ALU—general teachers for primary and lower secondary*) could not be reached in their final year because nearly all of them were spending this time outside the institutions. Therefore, future teachers from this program were tested (in deviation from the international study design) at the time when they were taking their compulsory mathematics courses. This period of study could occur within the future teachers' fourth or sixth semester. Future teachers following the program-types *ALU—general teachers for primary and lower secondary* and *ALU—general teachers for primary and lower-secondary schools with special program for mathematics* were being prepared to teach mathematics to primary and lower-secondary students. They were therefore considered to be eligible for both future teacher target populations. Both types of survey booklets (primary and lower secondary) were distributed evenly among the future teachers from these program-types. The two program-types therefore appear twice in Exhibit C8.1. Note, however, that only one institutional program questionnaire was completed for each teacher preparation unit belonging to these program-types. The survey of educators was not implemented according to the international sampling procedures. TEDS-M therefore considered it to be a national option. Educator data from Norway are therefore not part of the international dataset.

Exhibit C8.1: Sample design in Norway (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	ALU—general teachers for primary and lower secondary	16	12	16	1,429	392
	2	ALU—general teachers for primary and lower secondary with special program for mathematics	16	14	16	433	159
Total	**2**		**32**	**26**	**32**	*****	**551**
Level: Lower secondary							
Concurrent	1	ALU—general teachers for primary and lower secondary	16	10	**	1,506	356
	2	ALU—general teachers for primary and lower secondary with special program for mathematics	16	13	**	480	151
Consecutive	3	PPU—teachers in lower- and higher-secondary school	7	5	6	78	43
Concurrent	4	Master's—teachers in lower- and higher-secondary school	6	5	5	28	22
Total	**4**		**45**	**33**	**43**	*****	**572**

Notes:
* Because of partly overlapping populations, a total could not be calculated. The amount of overlap is unknown.
** Identical to the corresponding entries in the part of the exhibit dedicated to the primary level.

Exhibit C8.2: Mapping program-types to groups defined for reporting purposes (Norway)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
ALU—general teachers for primary and lower secondary	Primary/lower-secondary generalist (Grade 10 maximum)	Lower-secondary mathematics (to Grade 10 maximum)
ALU—general teachers for primary and lower secondary with special program for mathematics	Primary/lower-secondary generalist (Grade 10 maximum)	Lower-secondary mathematics (to Grade 10 maximum)
PPU—teachers in lower- and higher-secondary school	–	Upper-secondary mathematics (to Grade 11 and above)
Master's—teachers in lower- and higher-secondary school	–	Upper-secondary mathematics (to Grade 11 and above)

9. OMAN

Sample design:	Census of institutions, educators, and future lower-secondary teachers.
Total number of TEDS-eligible institutions:	Seven.
Coverage:	One hundred percent in the target populations of institutions, educators, and future lower-secondary teachers
Exclusions:	None.
Particularities:	No future primary teachers were being prepared at the time of the TEDS-M survey.

Exhibit C9.1: Sample design in Oman (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher survey)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Lower secondary							
Concurrent	1	Bachelor of Education, four years	1	1	1	36	30
	2	Educational diploma after Bachelor of Science, six years	1	1	1	17	16
	3	Bachelor of Education, four years, colleges of education	6	6	6	235	222
Total	**3**		**7***	**7***	**8**	**288**	**268**

Note: *The numbers in the column do not add up to the total because some institutions were offering more than one program.

Exhibit C9.2: Mapping program-types to groups defined for reporting purposes (Oman)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Bachelor of Education, four years	–	Upper-secondary mathematics (to Grade 11 and above)
Educational diploma after Bachelor of Science, six years	–	Upper-secondary mathematics (to Grade 11 and above)
Bachelor of Education, four years, colleges of education	–	Upper-secondary mathematics (to Grade 11 and above)

Exhibit C9.3: Sample design in Oman (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	64	51
General pedagogy educators	37	31
Educators of mathematics and mathematics pedagogy and general pedagogy	2	2
Total	**103**	**84**

Note: Number of institutions participating in educator survey: seven.

10. PHILIPPINES

Sample design:	Most institutions in the Philippines offering education to future mathematics teachers were very small compared to the corresponding institutions in the other participating TEDS-M countries. The institutions in the Philippines had, on average, 13 primary and 10 lower-secondary future teachers in their final year. About one half of the institutions were offering teacher education for both levels, while one fourth was offering education for the primary level only, and one fourth for the lower-secondary level only. Also, prior to sampling, a reliable measure of size was not available for about two thirds of all institutions. Furthermore, it was expected that a significant proportion of the institutions of an unknown size would not be eligible for TEDS-M (i.e., would not have future mathematics teachers in their final year). The sampling strategy considered these constraints in terms of the explanations provided in the following bullet points. • *Explicit stratification:* Prior to sampling, the TEDS-M sampling team stratified the lists of institutions by overlap (institutions offering education to either future primary or future lower-secondary teachers only, or to both, respectively) and size measures. The resulting strata reflected the sizes of the institutions and their allocation to the different levels (see Exhibit C10.1). The first intention of a strictly proportional allocation of the sample across the explicit strata was abandoned because there was a high risk of losing, due to ineligibility, too many institutions in the strata that had institutions of unknown size. Consequently, the sample size in these strata was decreased slightly, but increased significantly in the other strata. The sample sizes were therefore larger than the minimum of 50 selected institutions per level. • *Implicit stratification:* Prior to sample selection, the sampling team ordered the sampling frame by region within the explicit stratum. In all strata containing institutions of unknown size (Strata 2, 5, and 8), institutions were selected with equal probability. In the other strata, sampling with probability proportional to size was employed. In total, 80 institutions were selected for the survey. Selected institutions offering education for both levels were selected for both levels. This led to a sample of 60 institutions per level. Within two large institutions, the sampling team selected a sample of future teachers from each. In all other institutions, all eligible future teachers were asked to participate in the survey.
Total number of TEDS-eligible institutions:	Four hundred and seventy-six institutions were listed on the sampling frame. During the process of contacting selected institutions, the sampling team found that 25 percent of these institutions were ineligible for the TEDS-M survey. Consequently, the sample estimate of the number of TEDS-eligible institutions in the Philippines was relatively much smaller (289 institutions) than the number of institutions listed.
Coverage:	One hundred percent in all target populations.
Exclusions:	Very small institutions (i.e., fewer than five future primary teachers and fewer than three future lower-secondary teachers per institution) were excluded prior to sampling. This omission led to an exclusion rate of 7.4 percent of institutions, 2.1 percent of future primary teachers, and 1.7 percent of future lower-secondary teachers.
Particularities:	Explicit Strata Number 2 (primary only—institutions of unknown size) and Number 5 (lower secondary only—institutions of unknown size) were dropped completely because almost all or all of the selected institutions in these strata turned out to be ineligible.

Exhibit C10.1: Explicit stratification and sample allocation in the Philippines

Explicit Stratum	No.	Stratum Size*		Sample Size**	
		Institutions	*Future teachers*	*Institutions*	*Future teachers*
Level: Primary					
Primary only—small institutions	1	16	211	2	14
Primary only—institutions of unknown size	2	127	1,651	0	0
Primary and lower secondary—small institutions	6	33	268	3	19
Primary and lower secondary—large institutions	7	39	1,046	20	416
Primary and lower secondary—institutions of unknown size	8	109	1,417	8	143
Total	**5**	**324**	**4,593**	**33**	**592**
Level: Lower secondary					
Lower secondary only—small institutions	3	57	337	3	28
Lower secondary only—large institutions	4	29	611	11	203
Lower secondary only—institutions of unknown size	5	31	310	0	0
Primary and lower secondary—small institutions	6	33	218	4	18
Primary and lower secondary—large institutions	7	39	700	21	374
Primary and lower secondary—institutions of unknown size	8	109	1,090	9	110
Total	**6**	**298**	**3,266**	**48**	**733**

Notes:
* As estimated on the sampling frame, after exclusion.

Exhibit C10.2: Sample design in the Philippines (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Bachelor in Elementary Education	171	33*	33	2,921	592
Total	**1**		**171**	**33**	**33**	**2,921**	**592**
Level: Lower secondary							
Concurrent	2	Bachelor in Secondary Education	252	48**	48	3,135	733
Total	**1**		**252**	**48**	**48**	**3,135**	**733**

Notes:
* Of the 60 institutions selected, 19 were ineligible.
** Of the 60 institutions selected, 7 were ineligible.

Exhibit C10.3: Mapping program-types to groups defined for reporting purposes (Philippines)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Bachelor in Elementary Education	Primary generalist (Grade 6 maximum)	–
Bachelor in Secondary Education	–	Lower-secondary mathematics (to Grade 10 maximum)

Exhibit C10.4: Sample design in the Philippines (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	840	194
General pedagogy educators	1,309	279
Educators of mathematics and mathematics pedagogy and general pedagogy	698	116
Total	**2,847**	**589**

Note: Number of institutions participating in the educator survey: 51.

11. POLAND

Sample design:	Census of institutions and samples of educators and future teachers.
Total number of TEDS-eligible institutions:	One hundred and five.
Coverage:	Consecutive programs were not covered, thus reducing the coverage rates to the following levels: 81.5 percent of institutions, 76.4 percent of future primary teachers, and 71.0 percent of future lower-secondary teachers. The coverage rate for educators could not be specified because Poland could not provide the needed information.
Exclusions:	Four very small institutions were excluded (fewer than five future primary teachers and fewer than three future lower-secondary teachers, respectively, per institution). This omission led to the following exclusion rates: 3.8 percent of institutions, 3.0 percent of future primary teachers, and 0.4 percent of future lower-secondary teachers. The exclusion rate of educators was estimated as being below 5.0 percent.
Particularities:	Many universities in Poland have two different departments, each of which offers one of the general routes—mathematics or pedagogy. TEDS-M considered these departments to be different institutions for three reasons: 1. In general, they operate independently from one another; 2. They tend to be located at different places; 3. The educators are associated with one of the departments only and teach only in exceptional instances in the "partner" department. In a deviation from the international sampling plan, financial restrictions necessitated setting the maximum sample size to 30 future teachers per teacher preparation unit in all institutions. Future teachers following the route mathematics, concurrent were being prepared to teach mathematics to primary and lower-secondary students. TEDS-M therefore considered them to be eligible for both future teacher target populations. Both survey booklet types (primary and lower secondary) were distributed evenly among the future teachers within the respective program-type. These program-types appear twice in Exhibit C11.1. Note, however, that only one institutional program questionnaire was completed for each teacher preparation unit. TEDS-M considered the future teachers following the "second-cycle" programs to be out of scope for the TEDS-M core survey because they qualified as practicing teachers after completing their "first-cycle" studies. However, they were still surveyed according to the TEDS-M rules because in Poland very large proportions of first-cycle students enter the second-cycle programs before they enter the teaching profession, and ultimately contribute considerably to the country's teaching force. TEDS-M deemed the survey of these teachers to be a national option. (For more information, see Exhibit C11.3.)

Exhibit C11.1: Sample design in Poland (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Mathematics, concurrent	1	Mathematics (first-cycle fulltime teacher education programs), three years	18	16	17	459	134
	3	Mathematics (long-cycle fulltime teacher education programs), five years	17	15	15	696	123
	4	Mathematics (first-cycle parttime teacher education programs), three years	2	4	4	67	20
	6	Mathematics (long-cycle parttime teacher education programs), five years	5	4	3	91	23
Pedagogy, integrated teaching, concurrent	7	Pedagogy—integrated teaching (first-cycle fulltime programs), three years	33	27	26	1,206	510
	9	Pedagogy—integrated teaching (long-cycle fulltime programs), five years	16	14	14	864	268
	10	Pedagogy—integrated teaching (first-cycle parttime programs), three years	45	37	36	2,195	828
	12	Pedagogy—integrated teaching (long-cycle parttime programs), five years	12	10	10	566	206
Total	**8**		**91***	**78***	**125**	**6,144**	**2,112**
Level: Lower secondary							
Mathematics, concurrent	1	Mathematics (first-cycle fulltime teacher education programs), three years	19	15	17	497	135
	3	Mathematics (long-cycle fulltime teacher education programs), five years	16	13	15	700	122
	4	Mathematics (first-cycle parttime teacher education programs), three years	5	4	4	73	23
	6	Mathematics (long-cycle parttime teacher education programs), five years	4	3	3	74	18
Total	**4**		**28***	**23***	**39**	**1,344**	**298**

Note: *The numbers in the column do not add up to the total because some institutions were offering more than one program.

Exhibit C11.2: Mapping program-types to groups defined for reporting purposes (Poland)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Mathematics (first-cycle fulltime teacher education programs), three years	Primary mathematics specialist	Lower-secondary mathematics (to Grade 10 maximum)
Mathematics (long-cycle full-time teacher education programs), five years	Primary mathematics specialist	Upper-secondary mathematics (to Grade 11 and above)
Mathematics (first-cycle parttime teacher education programs), three years	Primary mathematics specialist	Lower-secondary mathematics (to Grade 10 maximum)
Mathematics (long-cycle parttime teacher education programs), five years	Primary mathematics specialist	Upper-secondary mathematics (to Grade 11 and above)
Pedagogy—integrated teaching (first-cycle fulltime programs), three years	Lower-primary generalist (Grade 4 maximum)	–
Pedagogy—integrated teaching (long-cycle fulltime programs), five years	Lower-primary generalist (Grade 4 maximum)	–
Pedagogy—integrated teaching (first-cycle parttime programs), three years	Lower-primary generalist (Grade 4 maximum)	–
Pedagogy—integrated teaching (long-cycle parttime programs), five years	Lower-primary generalist (Grade 4 maximum)	–

Exhibit C11.3: National option: sample design in Poland, second-cycle programs (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
	2	Mathematics (second-cycle fulltime teacher education programs), two years	7	6	6	139	33
	5	Mathematics (second-cycle parttime teacher education programs), two years	7	6	7	279	60
	8	Pedagogy—integrated teaching (second-cycle fulltime programs), two years	6	4	5	122	72
	11	Pedagogy—integrated teaching (second-cycle parttime programs), two years	19	14	17	1,265	293
Total	**4**		**30***	**23***	**35**	**1,805**	**458**
Level: Lower secondary							
	2	Mathematics (second-cycle fulltime teacher education programs), two years	6	5	6	102	30
	5	Mathematics (second-cycle parttime teacher education programs), two years	7	6	7	259	59
Total	**2**		**12***	**9***	**13**	**361**	**89**

Note: *The numbers in the column do not add up to the total because some institutions were offering more than one program.

Exhibit C11.4: Mapping program-types to groups defined for reporting purposes (Poland, national option)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Mathematics (second-cycle fulltime teacher education programs), two years	Primary mathematics specialist	Upper-secondary mathematics (to Grade 11 and above)
Mathematics (second-cycle parttime teacher education programs), two years	Primary mathematics specialist	Upper-secondary mathematics (to Grade 11 and above)
Pedagogy—integrated teaching (second-cycle fulltime programs), two years	Lower-primary generalist (Grade 4 maximum)	–
Pedagogy—integrated teaching (second-cycle parttime programs), two years	Lower-primary generalist (Grade 4 maximum)	–

Exhibit C11.5: Sample design in Poland (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	766	455
General pedagogy educators	386	255
Educators of mathematics and mathematics pedagogy and general pedagogy	28	24
Total	**1,180**	**734**

Note: Number of institutions participating in educator survey: 72.

12. RUSSIAN FEDERATION

Sample design: Of the 182 eligible institutions in the Russian Federation, 58 were selected for the survey, with selection probabilities proportional to their sizes. Future teacher enrollment data were used for the size measure. Sampled institutions offering education to both levels were sampled for both levels. This aspect of the sampling applied to 44 institutions. In addition, eight institutions offering education to future primary teachers and six institutions offering education to future lower-secondary teachers were selected. Up to four session groups were selected from the selected institutions and all future teachers within those groups were then asked to participate in the survey.

- *Explicit stratification:* Prior to sampling, the sampling frame was stratified by overlap between the levels. This process led to three explicit strata (see Exhibit C12.1).
- *Implicit stratification:* The sampling frame was ordered by type of institution (supporting organization) prior to sample selection. The different implicit strata were:
  - Higher pedagogical institutions
  - State universities
  - Other higher institutions.

Total number of TEDS-eligible institutions: One hundred and eighty-two.

Coverage: So-called “secondary pedagogical institutions” were not covered because they were about to be phased out at the time of the TEDS-M survey. These institutions provided teacher education for the primary level only. No information was available about the proportion of future primary teachers enrolled in these institutions at the time of testing; also, exactly when these institutions would be phased out remained uncertain.

Exclusions: None.

Particularities: None.

Exhibit C12.1: Explicit stratification and sample allocation in the Russian Federation

Explicit Stratum	No.	Stratum Size*		Sample Size**	
		Institutions	*Future teachers*	*Institutions*	*Future teachers*
Level: Primary					
Primary only	1	61	3,186	8	248
Primary and lower secondary	3	101	12,432	41	2,018
Total	**2**	**162**	**15,618**	**49**	**2,266**
Level: Lower secondary					
Lower secondary only	2	19	655	6	205
Primary and lower secondary	3	101	6,217	42	1,936
Total	**2**	**120**	**6,872**	**48**	**2,141**

Notes:
* As estimated on the sampling frame, after exclusion.
** Participants in future teacher survey.

Exhibit C12.2: Sample design in the Russian Federation (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Teacher of primary school	161	49	45	8,563	2,266
Total	**1**		**161**	**49**	**45**	**8,563**	**2,266**
Level: Lower secondary							
Concurrent	2	Teacher of mathematics	116	48	43	5,915	2,141
Total	**1**		**116**	**48**	**43**	**5,915**	**2,141**

Exhibit C12.3: Mapping program-types to groups defined for reporting purposes (Russian Federation)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Teacher of primary school	Lower-primary generalist (Grade 4 maximum)	–
Teacher of mathematics	–	Upper-secondary mathematics (to Grade 11 and above)

Exhibit C12.4: Sample design in the Russian Federation (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	2,404	920
General pedagogy educators	646	275
Educators of mathematics and mathematics pedagogy and general pedagogy	85	17
Total	**3,135**	**1,212**

Note: Number of institutions participating in the educator survey: 56.

13. SINGAPORE

Sample design:	Census of institutions, educators, and future teachers.
Total number of TEDS-eligible institutions:	One.
Coverage:	One hundred percent in all target populations.
Exclusions:	None.
Particularities:	None.

Exhibit C13.1: Sample design in Singapore (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Diploma in Education (General, Primary), Option A	1	1	1	53	45
	2	Diploma in Education (General, Primary), Option C	1	1	1	119	107
	3	Bachelor of Arts (Education), Primary	1	1	1	33	31
	4	Bachelor of Science (Education), Primary	1	1	1	42	36
Consecutive	5	Postgraduate Diploma in Education (Primary), Option A	1	1	1	75	72
	6	Postgraduate Diploma in Education (Primary), Option C	1	1	1	102	89
Total	**6**		**1***	**1***	**6**	**424**	**380**
Level: Lower secondary							
Consecutive	7	Postgraduate Diploma in Education (Secondary), January 2007 intake	1	1	1	111	105
	8	Postgraduate Diploma in Education (Secondary), teacher of lower-secondary mathematics, January 2007 intake	1	1	1	67	50
	9	Postgraduate Diploma in Education (Secondary), July 2007 intake	1	1	1	153	146
	10	Postgraduate Diploma in Education (Secondary), teacher of lower-secondary mathematics, July 2007 intake	1	1	1	100	92
Total	**4**		**1***	**1***	**4**	**431**	**393**

Note: *The numbers in the column do not add up to the total because Singapore provided only one teacher preparation institution, offering all listed programs.

Exhibit C13.2: Mapping program-types to groups defined for reporting purposes (Singapore)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Diploma in Education (General, Primary), Option A	Primary mathematics specialist	–
Diploma in Education (General, Primary), Option C	Primary generalist (Grade 6 maximum)	–
Bachelor of Arts (Education), Primary	Primary generalist (Grade 6 maximum)	–
Bachelor of Science (Education), Primary	Primary generalist (Grade 6 maximum)	–
Postgraduate Diploma in Education (Primary), Option A	Primary mathematics specialist	–
Postgraduate Diploma in Education (Primary), Option C	Primary generalist (Grade 6 maximum)	–
Postgraduate Diploma in Education (Secondary), January 2007 intake	–	Upper-secondary mathematics (to Grade 11 and above)
Postgraduate Diploma in Education (Secondary), teacher of lower-secondary mathematics, January 2007 intake	–	Lower-secondary mathematics (to Grade 10 maximum)
Postgraduate Diploma in Education (Secondary), July 2007 intake	–	Upper-secondary mathematics (to Grade 11 and above)
Postgraduate Diploma in Education (Secondary), teacher of lower-secondary mathematics, July 2007 intake	–	Lower-secondary mathematics (to Grade 10 maximum)

Exhibit C13.3: Sample design in Singapore (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	30	25
General pedagogy educators	61	52
Educators of mathematics and mathematics pedagogy and general pedagogy		
Total	**91**	**77**

Note: Number of institutions participating in the educator survey: one.

14. SPAIN (PRIMARY EDUCATION ONLY)

Sample design:	Fifty institutions, with selection probabilities proportional to their size, were selected from the 72 institutions identified. A sample of educators and a sample of future teachers were selected from each of the selected institutions.
Total number of TEDS-eligible institutions:	Seventy-two.
Coverage:	One hundred percent in all target populations.
Exclusions:	None.
Particularities:	Identification of future teachers in their final year according to the TEDS-M definition turned out to be a particular challenge in Spain. First, future teachers in Spain are relatively free to decide in what order they complete their required courses. Second, large numbers of future teachers stay registered at the institutions (for a variety of reasons) by enrolling in a single course without actually attending it. These students were not deemed of interest to TEDS-M. The Spanish national sampling team, however, endeavored to compile an accurate and comprehensive list of future primary teachers within each selected institution who could be deemed of interest to TEDS-M. A student was considered as being in target if (i) he or she was registered in a minimum of two courses, and (ii) if he or she would qualify as a teacher on successfully completing these courses.

Exhibit C14.1: Sample design in Spain (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Teacher of primary education	72	45	48	3,845	1,093
Total	**1**		**72**	**45**	**48**	**3,845**	**1,093**

Exhibit C14.2: Mapping program-types to groups defined for reporting purposes (Spain)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Teacher of primary education	Primary generalist (Grade 6 maximum)	–

Exhibit C14.3: Sample design in Spain (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	160	120
General pedagogy educators	586	400
Educators of mathematics and mathematics pedagogy and general pedagogy	24	13
Total	**770**	**533**

Note: Number of institutions participating in educator survey: 46.

15. SWITZERLAND (GERMAN-SPEAKING PARTS ONLY)

Sample design:	Census of institutions and future teachers and sample of educators.
Total number of TEDS-eligible institutions:	Sixteen.
Coverage:	One hundred percent in all target populations. The TEDS-M target population in Switzerland included only (but in actuality all) institutions where German was the primary language of use and instruction. The population did not include institutions operating in other national languages. Within this restriction, full coverage was obtained in all target populations.
Exclusions:	None.
Particularities:	Because of specific data-protection requirements in Switzerland, TEDS-M collapsed some program-types within the publicly available datasets. Program-Type Numbers 1 and 2 were collapsed into a category called *kindergarten/lower primary*; Program-Type Numbers 3, 4, and 5 were collapsed into a category called *primary*.

Exhibit C15.1: Sample design in Switzerland, German-speaking parts only (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Teacher for kindergarten and primary school (kindergarten and Grades 1–3)	5	5	5	106	75
	2	Teacher for kindergarten and primary school (kindergarten and Grades 1–3)	2	2	2	54	46
	3	Teacher for kindergarten and primary school (kindergarten and Grades 1–6)	2	2	2	304	235
	4	Teacher for primary school (Grades 1–6)	12	12	10	745	556
	5	Teacher for primary school (Grades 3–6)	2	2	2	43	24
Total	**5**		**14***	**14***	**21**	**1,252**	**936**
Level: Lower secondary							
Concurrent	6	Teacher for secondary school	6	6	7	177	141
Total	**1**		**6**	**6**	**7****	**177**	**141**

Notes:
* The numbers in the column do not add up to the total because some institutions were offering more than one program.
** One institution specified two programs of the same type.

Exhibit C15.2: Mapping program-types to groups defined for reporting purposes (Switzerland, German-speaking parts only)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Teacher for kindergarten and primary school (kindergarten and Grades 1–2)	Lower-primary generalist (Grade 4 maximum)	–
Teacher for kindergarten and primary school (kindergarten and Grades 1–3)	Lower-primary generalist (Grade 4 maximum)	–
Teacher for kindergarten and primary school (kindergarten and Grades 1–6)	Primary generalist (Grade 6 maximum)	–
Teacher for primary school (Grades 1–6)	Primary generalist (Grade 6 maximum)	–
Teacher for primary school (Grades 3–6)	Primary generalist (Grade 6 maximum)	–
Teacher for secondary school I	–	Lower-secondary mathematics (to Grade 10 maximum)

Exhibit C15.3: Sample design in Switzerland, German-speaking parts only (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	77	51
General pedagogy educators	338	168
Educators of mathematics and mathematics pedagogy and general pedagogy	1	1
Total	**416**	**220**

Note: Number of institutions participating in educator survey: 12.

16. THAILAND

Sample design:	Census of institutions, educators, and future teachers.
Total number of TEDS-eligible institutions:	Forty-six.
Coverage:	One hundred percent in all target populations.
Exclusions:	None.
Particularities:	Because all future teachers in Thailand are prepared to teach mathematics to both primary and secondary students, TEDS-M considered them to be eligible for both future teacher target populations. Both types of survey booklet (primary and lower secondary) were distributed evenly among the future teachers. Both specified program-types therefore appear twice in Exhibit C16.1. Note that only one institutional program questionnaire was completed for each teacher preparation unit belonging to the respective program-type. Thailand changed its former Bachelor of Education four-year program to a five-year program after the 2007 class graduated. Therefore, in order to capture this cohort, and in deviation from the international sampling plan, the survey was administered to those future teachers following the program Bachelor of Education at the end of their penultimate year.

Exhibit C16.1: Sample design in Thailand (institution and future teacher surveys)

Route	No.	Program-Type	Institutions			Future Teachers	
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Bachelor of Education	45	44	42	1,240	599
Consecutive	2	Graduate Diploma in Teaching Profession	9	9	9	124	61
Total	**2**		**46***	**45***	**51**	**1,364**	**660**
Level: Lower secondary							
Concurrent	1	Bachelor of Education	**	**	**	1,244	596
Consecutive	2	Graduate Diploma in Teaching Profession	**	**	**	124	56
Total	**2**		**	**	**	**1,368**	**652**

Notes:
* The numbers in the column do not add up to the total since some institutions were offering more than one program.
** Identical to the corresponding entries in the part of the table dedicated to the primary level.

Exhibit C16.2: Mapping program-types to groups defined for reporting purposes (Thailand)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Bachelor of Education	Primary mathematics specialist	Upper-secondary mathematics (to Grade 11 and above)
Graduate Diploma in Teaching Profession	Primary mathematics specialist	Upper-secondary mathematics (to Grade 11 and above)

Exhibit C16.3: Sample design in Thailand (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	138	121
General pedagogy educators	128	117
Educators of mathematics and mathematics pedagogy and general pedagogy	88	74
Total	**354**	**312**

Note: Number of institutions participating in the educator survey: 43.

17. UNITED STATES OF AMERICA (PUBLIC INSTITUTIONS ONLY)

Sample design:

The sampling frame contained all public teacher preparation institutions in the United States. Sixty institutions were selected from the 498 TEDS-eligible institutions, with selection probabilities proportional to their size. Selection was also based on the assumption that all institutions were offering education to both future primary teachers and future secondary teachers. All program-types of interest to TEDS-M from within the selected institutions were included.

Prior to sampling, the sampling frame was stratified explicitly by

- The Carnegie Foundation classification of higher education institutions:
  - Type 1: Offering PhDs requiring a high level of research
  - Type 2: Offering other PhDs
  - Type 3: MA highest degree granted
  - Type 4: BA/BSc highest degree granted.
- Middle school certification:
  - 1: State grants this certification
  - 0: State does not grant this certification.
- Carnegie Foundation size category:
  - Large
  - Medium/small
  - All.

This process led to 10 explicit strata (see C17.1).

Total number of TEDS-eligible institutions: Four hundred and ninety-eight.

Coverage: One hundred percent in all target populations.

Public institutions accounted for 37 percent of the institutions in total and slightly more than 60 percent of the populations of future teachers, setting the sum of public and private institutions to 100 percent. The only routes covered within the public institutions were the concurrent and consecutive ones.

Exclusions: None.

Particularities:

In deviation from the international sampling plan, financial restrictions made it necessary to set the maximum sample size to 30 future teachers per teacher preparation unit in all institutions.

In the USA, teachers following the program-types *primary and secondary concurrent* and *primary and secondary consecutive* are prepared to teach mathematics to both primary and lower-secondary students. TEDS-M therefore considered these future teachers to be eligible for both future teacher target populations. Both survey booklet types (i.e., primary and lower secondary) were distributed evenly among these future teachers. These program-types therefore appear twice in C17.2. Note that only one institutional program questionnaire was completed for each teacher preparation unit belonging to these program-types.

Because of extremely low participation rates in the target population of educators, educator data for the United States were neither weighted nor reported together with the educator data from the other participating countries.

Exhibit C17.1: Explicit stratification and sample allocation in the United States

Explicit Stratum*	No.	Stratum Size**		Sample Size***			
				Level: Primary		*Level: Lower secondary*	
		Institutions	*Future teachers*	Institutions	Future teachers	Institutions	Future teachers
Type1/Cert0/large	1	35	5,710	4	156	4	92
Type1/Cert1/large	2	27	4,385	4	96	4	76
Type2/Cert0/all	3	37	8,258	6	172	5	81
Type2/Cert1/all	4	60	9,019	7	206	6	67
Type3/Cert0/large	5	33	5,002	3	88	3	47
Type3/Cert0/medium–small	6	79	8,980	8	256	7	105
Type3/Cert1/large	7	23	4,315	4	112	4	37
Type3/Cert1/medium–small	8	120	11,247	10	310	10	70
Type4/Cert0/all	9	32	1,358	2	53	2	4
Type4/Cert1/all	10	52	2,368	3	52	1	28
Total	**10**	**498**	**60,642**	**51**	**1,501**	**46**	**607**

Notes:

* Full stratum names not available.

** As estimated on the sampling frame. This estimation turned out to be highly inaccurate (compared with population estimates from sample data in Exhibit C17.2.).

*** Participants in future teacher survey.

Exhibit C17.2: Sample design in the United States (institution and future teacher surveys)

Route	No.	Program-Type	Institutions		Future Teachers		
			Population (sample estimate)	*Participants (future teacher surveys)*	*Completed IPQs*	*Population (sample estimate)*	*Participants*
Level: Primary							
Concurrent	1	Primary/concurrent	382	48	46	20,597	1,137
	3	Primary and secondary/ concurrent	74	15	12	3,472	184
Consecutive	4	Primary/consecutive	81	13	10	2,031	173
	6	Primary and secondary/ consecutive	20	3	3	172	7
Total	**4**		**404***	**51***	**71**	**26,272**	**1,501**
Level: Lower secondary							
Concurrent	2	Secondary/concurrent	303	42	35	2,246	356
	3	Primary and secondary/ concurrent	87	15	**	4,036	161
Consecutive	5	Secondary/consecutive	85	12	11	620	82
	6	Primary and secondary/ consecutive	22	3	**	196	8
Total	**4**		**327***	**46***	**61**	**7,098**	**607**

Note:

* The numbers in the column do not add up to the total because some institutions were offering more than one program.

** Identical to the corresponding entries in the part of the table dedicated to the primary level.

Exhibit C17.3: Mapping program-types to groups defined for reporting purposes (United States)

Program-Type	Program-Group (Level: Primary)	Program-Group (Level: Lower Secondary)
Primary/concurrent	Primary generalist (to Grade 6 maximum)	–
Primary and secondary/concurrent	Primary mathematics specialist	Lower-secondary mathematics (to Grade 10 maximum)
Primary/consecutive	Primary generalist (to Grade 6 maximum)	–
Primary and secondary/consecutive	Primary mathematics specialist	Lower-secondary mathematics (to Grade 10 maximum)
Secondary/concurrent	–	Upper-secondary mathematics (to Grade 11 and above)
Secondary/consecutive	–	Upper-secondary mathematics (to Grade 11 and above)

Exhibit C17.4: Sample design in the United States (educator survey)

Educator-Group	Population (Sample Estimate)	Participants
Educators of mathematics and mathematics pedagogy	*	115
General pedagogy educators	*	118
Educators of mathematics and mathematics pedagogy and general pedagogy	*	8
Total	*****	**241**

Note:
Number of institutions participating in educator survey: 14.
*Data remained unweighted; estimates of population totals cannot be given.

APPENDIX D:
TEDS-M Sampling Frame Questionnaire and Forms

Appendix D TEDS-M 2008
SAMPLING FRAME Questionnaire

TEDS-M includes a study of the routes of primary and lower-secondary mathematics teacher education in each participating country. By "route" we mean the sequence of opportunities to learn which lead future teachers to being considered fully qualified to teach in primary or lower-secondary school.

TEDS-M seeks to clearly identify routes in order to distinguish how they differ in major respects, such as the structure, the curriculum, the capabilities and backgrounds of their future teachers, and the grade levels and types of schools for which each route prepares graduates.

One reason we have to be clear about the routes in each country is that this is essential to comparability of analyses. In comparing routes across countries, we have to be able to distinguish easily, for example, between routes in which formal teacher education follows the completion of a university degree (known as *consecutive* routes) and routes in which formal teacher education and subject preparation are combined into a single program (*concurrent* routes).

Obtaining good information about routes however is not an easy task. In order to be able to compare across countries we need to first understand individual country situations.

This SAMPLING FRAME Questionnaire will be used by the International Study Centers to build the body of knowledge supporting TEDS-M and, in collaboration with our sub-contractors, the Sampling Team of the IEA Data Processing Center, to select the sample for this study in your country.

This sampling frame questionnaire will be complemented by a ROUTE Questionnaire to be sent later in July 2006.

Unless you nominate a sampling expert in your country to select the sample for this study, we will assume that TEDS-M will select the sample. We will do so using the information you are providing in this questionnaire, and if necessary, with further consultation with you.

PLEASE send preferably via e-mail the completed form to the MSU International Center (teds@msu.edu) with a copy to the IEA Data Processing Center (sampling@iea-dpc.de) no later than Friday, July 21st 2006.

Thank you very much for your prompt attention to this important questionnaire.

Warm regards,

Maria Teresa Tatto

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WORKING DEFINITIONS FOR THIS QUESTIONNAIRE

As you know this study is directed at exploring the education of future teachers of primary and lower-secondary levels. Throughout the questionnaire we will be referring to "primary" and "lower secondary" to encompass the different grades as organized in your education system.

Using UNESCO's International Standard Classification of Education (ISCED) levels, please indicate the grades that correspond to each primary, lower-secondary, and upper-secondary education level in your country. Please remember that when we refer to grades or when we use ISCED terms in this questionnaire, we will be referring to these levels and the corresponding grades as indicated by you in the table below.

We are also including the higher ISCED levels for post-secondary education, as we will use these terms in learning more about your future teachers' backgrounds.

According to the following table:

ISCED Levels	Education System	Types of Schools Offering These Grades as Known in Your Country	Grades in Your Country*	Students' Age Range	Other
ISCED 0	*Preprimary*		*Kindergarten or below*		
ISCED 1	*Primary or Basic Education Cycle 1*		*1st to* ______		
ISCED 2	*Lower Secondary or Basic Education Cycle 2*		______ *to* ______		
ISCED 3	*Upper Secondary or Post-Basic Education*		______ *to* ______		
ISCED 4	*Post-Secondary Non-Tertiary*		______ *to* ______		
ISCED 5	*Higher Education (2 years)*		______ *to* ______		
ISCED 6	*Higher Education (4 years)*		______ *to* ______		
ISCED 7	*Master's or Doctorate*		______ *to* ______		

* If there is a different OR more than one classification in your country, please indicate so in the column named "other."

SECTION ONE—GENERAL INFORMATION

Country ______________________

Name of the individual
answering this questionnaire: ______________________

Individual's email: ______________________

Individual's telephone: ______________________

Individual's fax: ______________________

Sources used in answering questionnaire (*check all that apply*):

- ☐ Official government statistics
- ☐ Other official documents
- ☐ First-hand knowledge of person responsible for answering this questionnaire
- ☐ Research documents
- ☐ Other documents
- ☐ Interviews
- ☐ Other (please specify) ______________________

SECTION TWO—BACKGROUND
(including overall statistics for use in calculating the relative size of each route)

1) What is the total number of *ISCED 1 school teachers* in your country (all routes, all systems or jurisdictions)? NOTE: If the exact data is not available, please estimate as best as you can, and indicate your basis for the estimate in a footnote. ______________________

   1a) What is the *lowest* grade level included in this statistic? ______________________

   1b) What is the *highest* grade level included in this statistic? ______________________

2) What is the total number of *ISCED 2* school teachers in your country (all routes, all systems or jurisdictions)? NOTE: If the exact data is not available, please estimate as best as you can, and indicate your basis for the estimate in a footnote. ______________________

   2a) What is the *lowest* grade level included in this statistic? ______________________

   2b) What is the *highest* grade level included in this statistic? ______________________

3) Please give the source(s) of these statistics:

____

____

Please break down these numbers of *ISCED 1* and *ISCED 2* school teachers by school and grade level if available and write this information in the indicated space or "cell." Please indicate, when appropriate, the number of school teachers teaching only mathematics or mathematics plus other subjects. Please use the rows and/or columns relevant to your country; cross out the unused rows or columns. If a "cell" given in a specific column/row is not relevant for your country situation, please mark with "NR." If the data requested is not available, please write down "NA."

Standardized Name and Name Given in Your Country	Student Age Range	Number of Schools	Total Number of Teachers	Number of Teachers Who *Only* Teach Mathematics	Number of Teachers Who Teach Mathematics *plus* Other Subjects
Grade 1					
Grade 2					
Grade 3					
Grade 4					
Grade 5					
Grade 6					
Grade 7					
Grade 8					
Grade 9					
Grade 10					
Other _____					

Notes:

(a) Some schools may offer both *ISCED 1* and *ISCED 2* education; they should be counted in each level.

(b) Please feel free to make as many comments as you need to help explain/clarify the situation in your country. Use as many additional pages as necessary and attach them to this document when sending it to us.

TEDS-M SAMPLING FRAME QUESTIONNAIRE

SECTION THREE—LIST OF ROUTES
*Identify all Teacher Education Routes within the Country **

COUNTRY NAME: ______________________________

#	Name of route Length in academic years (approx): [One academic year = = ____# months/12 months calendar year]	Route type	Important to TEDS-M	Number of institutions	Number of future teachers in last year of training who will teach mathematics** Proportion of the country total ISCED 1 future teachers trained in this route		Math only?	Number of future teachers in last year of training who will teach mathematics** Proportion of the country total ISCED 2 future teachers trained in this route		Math only?	Grades qualified to teach		School types
					ISCED 1 number	ISCED 1 percent		ISCED 2 number	ISCED 2 percent		ISCED 1	ISCED 2	
	Name ________ # Years ________												
	Name ________ # Years ________												
	Name ________ # Years ________												
	Name ________ # Years ________												
	Name ________ # Years ________												
	Name ________ # Years ________												
	Name ________ # Years ________												
	Name ________ # Years ________												
	TOTALS												

Notes:

* Please add as many rows as needed. Insert clarification comments or additional information in footnotes. For any cell which does not apply to the route in question, enter N/A for "Not Applicable."

** This includes total number of future teachers who will teach mathematics *as well as those who will teach* mathematics *plus* other subjects.

DEFINITIONS AND INSTRUCTIONS FOR COMPLETING THE TABLE ABOVE

An example using an imaginary country (we are calling this country "xyz") showing how to fill out the table provided above is included on page 8 of this document.

As you fill out the table, please enter the required information for each route, whether concurrent, consecutive, or apprenticeship, and whether it applies only to primary education, only to secondary education, or to both.

Please list *all* the routes in your country that prepare teachers who will teach mathematics in primary or lower-secondary school, regardless of their sizes, and regardless of whether the graduates will teach other subjects (in addition to mathematics) or not.

Completing the table

- ***TEDS route number:*** Please assign a consecutive number to the route starting with "1" for the first row, "2" for the second row, etc. After we get this information from the NRCs, TEDS-M will assign a TEDS-M Route ID, including the numbers you assign here (TR – country_name - *number*) to the routes elected for further study within a given country and for which additional information will be required.
- ***Name by which route is called in your country:*** List national terminology as well as English translation. If the route is commonly known with more than one name, include each of the most commonly used names. If the name is too lengthy for the table, use footnotes.
- ***Length of route in academic years:*** Write down how many academic years long is a particular route. If it varies, please give an approximate range. To have comparability please tell us how long is an academic year in your context by using the standard calendar year of 12 months (e.g., 9 months/12 months calendar year).
- ***Route type:*** Classify the route(s) in your country according to the following definitions. Use the suggested abbreviations: concurrent = CONCUR, consecutive = CONSEC, and apprenticeship = APPREN.
  - *Concurrent routes:* If a route consists of a single program that includes studies in the subjects future teachers will be teaching (academic studies), studies of pedagogy and education (professional studies), and practical experience in the classroom, the route is a ***concurrent*** *route*. CODE: CONCUR
  - *Consecutive routes:* If the route consists of a **first** phase for academic studies (leading to a degree or diploma), followed by a **second** phase of professional studies and practical experience (leading to a separate credential/qualification), the route is a ***consecutive*** *route*. Thus, no route can be considered consecutive if the institution or government authorities do not award a degree, diploma, or official certificate at the end of the first phase. Moreover, it may be customary or required for future teachers to do the first and second phases in different institutions. CODE: CONSEC
  - *Apprenticeship routes:* If the route consists predominantly of school-based experience with other institutions playing only a minor, marginal, supporting role, the route is an ***apprenticeship*** *route*. CODE: APPREN
- ***Importance of route to TEDS-M:*** As your country's NRC, make a judgment about the importance of collecting data from this route in TEDS-M. If you are sure that the route should be included in TEDS-M either because of the number of graduates or because it has special importance as a reform or exemplary program, enter "Y" for "yes." If you are sure it should not be included because it has none of these attributes, enter "N" for "no." If you are unsure, enter "P" for "perhaps."

- ***Number of institutions:*** Enter the number of teacher education institutions that offer the professional education component of this route. For *concurrent routes*, this means the institution which offers professional education after the academic studies component (typically it would be the same institution). For *consecutive routes*, this is the institution which offers the second phase of purely professional education (or so-called "second institution"); we will not be sampling anyone in the so-called "first institution" where future teachers do their academic studies only. Therefore, at this point we do not need information from this first institution. By institution, we mean the school, university, or other organization which offers courses or otherwise organizes the training of co-located groups of future teachers (hence, in multi-campus institutions, each campus with a different group of future teachers should be counted as a separate institution). Some institutions may offer more than one route; they should be counted separately in each of these routes. In the case of apprenticeship routes leave this column blank, since the definition of institutions offering such routes can differ radically across countries. *Please total the number of institutions in the last row of the table*.

- ***Number of future teachers in their last year of training who will teach mathematics:*** This includes the total number of future teachers who will teach mathematics and mathematics *plus* other subjects in their last year of training. If this number is not available, please enter the number of future teachers graduating the year before. If exact statistics are not available, please estimate as best you can; you may use, for instance, total enrolments. Explain these estimates with footnotes. *Please total the number of future teachers in the last row of the table*.

- ***Proportion of the country total ISCED 1 and ISCED 2 trained in this route (percent):*** In addition please indicate the proportion these teachers represent in relation to the total number of future teachers trained in the country at the ISCED 1 or ISCED 2 levels. *Please total the percent of teachers trained in the last row of the table*.

- ***Mathematics only?*** Enter "Y" for "yes" if the route is exclusively devoted to the production of teachers who are preparing to be mathematics specialists; enter "N" for "no" if the route produces teachers who will normally teach at least one other subject-matter in addition to mathematics. We need this information for both ISCED 1 and ISCED 2 future teachers.

- ***Grades qualified to teach:*** Insert the grade levels that persons completing the route are qualified to teach. Use both the national numbering system and an international numbering with the first grade of primary school numbered "1," second grade "2," and so on through the end of secondary school (even though the study focuses on lower-secondary school, we need to know whether the route prepares for upper-secondary school as well).

- ***School types:*** List all school types for which this route prepares teachers. If the terminology is lengthy, use abbreviations and provide a key. In the key give both the national terminology and English translation. In the table underline the name or abbreviation of the school type which receives the most graduates from this route.

- ***TOTAL:*** Please total the columns only for the shaded boxes in this row [includes the following columns: *"Number of institutions"; "Number of future teachers in their last year of training who will teach mathematics";* and "*Proportion of the country total ISCED 1 and ISCED 2 future teachers trained in this route (expressed as percent)"*].

COUNTRY: XYZ (i.e., imaginary country)

#	Name of route Length in academic years (approx): [One academic year = __9__ months/12 months/12 months calendar year]	Route type	Important to TEDS-M	Number of institutions	Number of future teachers in last year of training who will teach mathematics** Proportion of the country total ISCED1 future teachers trained in this route		Math only?	Number of future teachers in last year of training who will teach mathematics** Proportion of the country total ISCED2 future teachers trained in this route		Math only?	Grades qualified to teach		School types
					ISCED 1 number	ISCED 1 percent		ISCED 2 number	ISCED 2 percent		ISCED 1	ISCED 2	
1	Old licence program—primary level. 3 years	CONCUR	Yes	25	8,000	65.3%	N	500[1]	10.2%	N	1–6	7–8	All primary schools
2	New B.Ed primary level. 4 years	CONCUR	Yes	15	4,000	32.6%	N	N/A	N/A	N	1–6	N/A	All primary schools
3	B.Ed secondary level. 3 years	CONCUR	Yes	20	N/A	N/A	N	2,500[2]	51.0%	N	N/A	7–12[3]	All secondary schools, except lyceums
4	Program for academic teachers in vocational schools. 2 years	CONCUR	No—being phased out	10	N/A	N/A	N	600[4]	12.2%	N	N/A	7–10	Secondary vocational schools only[5]
5	Graduate certificate in educ. —secondary.[6] 4 years	CONSEC	Yes	20	N/A	N/A	N	500[7]	10.2%	N	N/A	7–12	All secondary schools including lyceums
6	Experimental program to prepare mathematics specialists for primary school. 4 years	CONCUR	Perhaps	10	250	2.0%	Y	N/A	N/A	Y	1–6	N/A	Primary schools designated to experiment with specialist math teachers
7	Experimental program to retrain engineers as mathematics teachers. 1 year	APPREN	Perhaps	N/A	N/A	N/A	Y	800	16.3%	Y	N/A	7–12	All secondary schools except lyceums
	TOTALS			100	12,250	99%		4,900	99%				

Notes:

1 There is no way to know how many of these future teachers will get jobs in Grades 7 and 8 as opposed to Grades 1–6, so this is our best estimate.
2 This route produces teachers for all secondary grades. We don't know how many are destined for lower secondary alone. This is our best estimate.
3 In xyz, the secondary grades are numbered in reverse order from the international numbering so that Grade 7 is called the 6th class and Grade 12 is called the 1st class.
4 Again this is an estimate because we don't know how many of these teachers will be assigned to the grade levels corresponding to the lower academic secondary school.
5 Known as *collèges techniques* in the national language.
6 Some institutions award a Master's degree for this program; in this case the program is called the Master's degree program in secondary school teaching.
7 Another estimate, taking into account that graduates of this program are more likely to teach in upper-secondary rather than lower-secondary school.

APPENDIX E:
Mobilizing National Support and Recruiting Institutions

The success of TEDS-M relied on national-level commitment. Because TEDS-M was the first study of higher education institutions using national representative samples ever attempted, few guidelines existed to help NRCs gain access to sample institutions and secure high survey response rates. The international research center (ISC) at Michigan State University therefore drafted the following instructions to the NRCs. These instructions were sent to each NRC after the third TEDS-M NRC meeting in Taipei, June 2007.

Instructions Sent to NRCs to Gain Access to and Secure High Response Rates

Organizing the Campaign to Support TEDS-M at the National Level

What is needed is a national campaign to emphasize the value and importance of TEDS-M and to encourage participation at the institutional and individual respondent level. The purpose is not only to get support for the study, but also to create a sense of ownership for the study among the leaders and decision-makers of teacher education.

We know that the same approach will not work in every country because countries differ in:

- Customary procedures for doing social and educational research
- Cultural norms for how to work with individuals, associations, and organizations
- Organization of higher education
- Size and heterogeneity of the country.

If the ministry responsible for tertiary education in your country requires every selected institution to participate in the study, obtaining permission for the survey administration is probably straightforward. But will it ensure the cooperation needed for high response rates? Getting sufficiently high response rates from educators and future teachers will take willing and enthusiastic participation by institutions, not just minimal compliance.

Moreover, higher education institutions in much of the world operate with a great deal of autonomy and are likely to feel that they can, if they wish, refuse to participate in any survey of higher education which they do not think is in their interest. It is essential in such cases that you prepare very carefully to obtain the cooperation of the institutions in the sample. This can be a long and challenging process. In fact, if you have not started this process already, the timeline needed will be very tight.

Before approaching institutions, it is often necessary to obtain the permission of state/provincial as well as national authorities. Often, the higher-level authorities give permission in such situations, with the understanding that it is ultimately the decision of each sampled institution as to whether or not to participate.

Issues to be addressed in planning your campaign include:

- What and who can give the study credibility and appeal among respondent groups?
- What will help respondent groups feel a sense of ownership for the study?
- What measures can NRCs take to make all this happen? What has to be done to get the support of all these individuals and groups?
- How can such persons and organizations be more involved in the study through advisory panels, expert panels, consultancies, etc?
- Who will be assigned specific responsibility to take the measures necessary for a successful campaign?

In particular, you should make a checklist of the authorities, leaders, and organizations at the national level that could support the study. In federalized countries, this effort will need to be directed at state/provincial leadership in teacher education as well. These include:

- Relevant ministry authorities
- Influential professional associations with individual membership, such as associations of mathematicians, mathematics educators, teacher educators, educational researchers, and teachers of mathematics at the secondary level
- Influential organizations with institutional membership such as associations of universities, faculties of education, teacher training colleges, state/provincial education ministers and agencies
- Teacher unions at all levels
- Well-known researchers and practitioners in mathematics education and teacher education more generally. If possible, get supporters on both sides of contentious teacher education and mathematics education debates.

Focus Groups

It is not enough to work with mathematicians and mathematics educators in getting support for this study. Faculties of education and teacher training colleges alike are most often run by people from other specialties or backgrounds. They have to be convinced that the study has value.

We have recommended a written plan as a way of working out a realistic, manageable schedule of activities. The plan should include any special meetings or conferences that are needed to publicize the study and to mobilize different target groups to support the study.

Hence, taking a draft plan to persons familiar with the respondent groups and the influential leaders of these groups will help you learn about how perceptions of the study vary among leaders of these groups and how they differ from those of the NRC team. If the meeting of experts and organizational representatives proves useful in formulating a plan for obtaining cooperation, it can be continued as an informal advisory board or panel to facilitate cooperation and ultimately dissemination throughout the study.

The best way to invite the views of stakeholders and respondents at this stage may be to use focus groups. For best results, the groups should be small and relatively homogeneous. If a focus group is too heterogeneous in terms of background and position of participants, the participants will be less candid and even less willing to talk. Thus, groups might be constituted as follows:

- Group of national leaders in mathematics education
- Group of national leaders in teacher education
- Group of key representatives of institutions that participated in the field trial
- Other groups of equal importance and influence
- Group(s) of future teachers.

Within the focus group, pick one or more of the following artifacts to discuss; ones that you think would get the most relevant, extensive and candid discussion within the group:

- Your draft plan to obtain cooperation
- Your draft letter inviting institutions to participate
- A PowerPoint presentation and/or a brochure describing the study.

Be sure to discuss perceptions of how the study is being managed with the focus groups and other respondents. Does the NRC's institution have sufficient credibility and legitimacy in higher education in general and teacher education in particular to be seen as the appropriate coordinating agency for the study? Is there a need to involve other institutions in overseeing and coordinating the study, especially if the study involves more than one route of teacher education or different types of teacher education institutions?

Use of Field Trial Results

Use the results of the field trial in developing your plan and campaign. In the earlier version of this manual, you were asked to develop a first draft of this plan for obtaining cooperation and acceptable response rates in this field trial. Use the field trial results for feedback on how best to approach institutions in the main study. It should have been easier to line up the institutions in the field trial than in the main study. In most cases, field trial institutions were fewer and they were chosen as a convenience rather than a probability sample or a census. Thus, in the field trial, you were perhaps able to get sufficient cooperation simply by using personal relationships between members of the NRC team and the chosen institutions.

Such personal relationships can prove very important in obtaining cooperation from institutions in the main study as well, but in the latter case it may be necessary to get cooperation from institutions where there are no personal relationships that could help. Thus, every aspect of getting institutional cooperation should be scrutinized at the main study stage and improved if possible. In particular, the Field Trial was an opportunity to find out if the arguments made for the benefits of the study to participating institutions are convincing or not. Also, if the initial group of experts and organizational representatives chosen to help get support for the study proved lacking in some respects at the time of the field trial, it can be revamped before it is too late.

Recruiting Sampled Institutions

Once you have obtained your national TEDS-M sample of institutions for the main study, you should prepare to contact them and invite them to participate. Contacting the sampled institutions requires professionalism, patience, and perseverance. It is extremely important that the sampled institutions participate in TEDS-M, since nonparticipation by sampled institutions affects overall participation rates for countries and may lead to bias in the results of the study. This means that success in the study depends on getting excellent cooperation from each of these institutions.

Issues to be addressed include:

- How do you convince institutions that the study is important and meaningful for them?
- In that regard, have you been able to articulate the benefits of the study to each institution in a convincing way?
- Is the NRC team comfortable with the response burden which institutions are being asked to accept? If not, it will be difficult to convince them.
- Is the institutional coordinator role defined in a way that is appropriate to the institutions in your country? Can one person get all the data required and influence all the people whose support is required or do the responsibilities need to be divided up among different persons to accomplish all these tasks?

We recognize that procedures for obtaining cooperation of institutions are likely to vary from country to country if they are to be successful. Each country has its own culture and customary ways of working with institutions in higher education. Thus, we can give only general guidelines for obtaining the cooperation of the sampled institutions, while encouraging each country to modify the procedures to fit its situation.

The plan mentioned above should include a section on approaching institutions and asking for their agreement to participate. The following are examples of the questions that such a plan should address, first to obtain cooperation of the institution as a whole and then to assure the cooperation of the educators and future teachers who will be surveyed within the institution:

- Who at the sampled institutions must be contacted and must agree before TEDS-M can be certain of cooperation from the institution in question? Do the prospective contacts vary as a function of the type, size, and heterogeneity of the institution?
- When should this approach be made?
- In many cases, it will also be necessary to visit the target institutions to meet with key administrators and educators in order to enlist their support before it will be possible to get the institution to agree, not just to participate, but also to do so effectively and enthusiastically. In such cases, the organization of such a meeting, the way in which the study is presented, and the person(s) making the presentation for TEDS-M are extremely important. For such meetings, it is essential that TEDS-M be represented by someone with high name recognition and an excellent reputation in mathematics teacher education or in teacher education.

- How much of the initial contact needs to be in the form of a visit to the institution or other face-to-face contacts as opposed to telephone calls and exchange of emails and written correspondence? We recommend a combination of a formal written letter of invitation and personal contacts. Cultural norms and customary ways of doing things will determine the best approach for each country in deciding, for example, whether the formal letter of invitation should be preceded, accompanied, or followed by personal contact. Customary procedures will also determine who should sign the letter. Ordinarily, the letter should be signed by a high official who is most likely to have influence on the institutions being invited. In countries where relationships between ministries and institutions of higher education are often strained, this should be considered when phrasing the letter and deciding who should sign it.
- What is being asked of the institution in terms of time, staffing, and participation of the respondent groups of future teachers and educators?
- What is the best procedure for choosing the institutional coordinator?
- What are the obstacles to obtaining adequate response rates and how can these obstacles be overcome?
- What incentives are necessary and sufficient to ensure willing participation of all those within each institution from whom data will be collected or who will be asked to help with the study in some other way?
- What schedule for data collection will work best? We recommend one that is as integrated with the institutional calendar as possible and can be accomplished with minimal disruption to the schedules of future teachers and educators.
- Who in the institution will be needed to answer the institutional questionnaire and how can we be sure that they will do this as accurately and exhaustively as possible?

List of Sampled Institutions

For those countries, where the sampling unit of the DPC was responsible for the sampling, you should have received the information about selected institutions and their replacements. Use this file to contact each of the sampled institutions. For more information on institution sampling procedures, please refer to the sample preparation manual.

Letter of Invitation

The letter of invitation should include the following elements, with modifications appropriate for the country and institution in question:

- *The purpose:* Explain the purpose of TEDS-M, attaching a short document describing the project and its significance. This attached document should be written in easily understood language so that copies can be distributed to the key administrators, educators, and others who have to be consulted before a decision is made about whether the institution will participate or not.
- *An invitation:* Invite the cooperation of the institution, emphasizing the importance of the institution's participation in order to achieve a representative sample.

- *The institution's role:* In the letter or attachment, outline what institution participation will involve (e.g., the students and educators who will be involved, the length of the data-collection sessions, the approximate time required for the completion of the questionnaires, etc.).
- *Dates:* Give the proposed dates during which the instruments are to be administered.
- *Benefits:* Indicate any benefits that individual institutions might receive from participating in the study (e.g., ways in which the findings can be used to improve teacher education within the institution). If it is within your capacity as NRC, you may offer a visit when the results of the study are published as a way to inform people about the outcomes of the study.
- *Confidentiality:* Guarantee the confidentiality of individual students, educators, and institutions in all publications of results. Discuss compliance with other human subject protection or other ethical requirements.
- *Further discussion:* Invite institution officials to contact you at the national center if they need further information before making a decision, or better yet, organize a joint session with institutions or offer to make a further visit to their institution to explain and justify the study to interested parties.
- *Institution coordinator's role:* Describe the role of the institution coordinator who will be responsible for convincing educators and students to participate as well as administrative arrangements for the TEDS-M main study in the institution. State that the institution coordinator could be either a staff member within the institution or a member of the national center in charge of the survey administration in a particular institution. Indicate that the selection of such a person needs to be discussed with the authorities at the institution to make sure the person chosen is satisfactory both for the institution and the national center.
- *Additional contacts:* Ask for the contact information of any additional person other than the institution coordinator to whom future correspondence should be addressed.

Follow-up Letters

Personnel in institutions agreeing to participate become essential partners in the TEDS-M main study. Be sure to follow up all contacts with letters expressing appreciation for cooperation and for whatever was accomplished during the contact.

Institution Coordinator

The choice of institutional coordinator is critical. To get sufficient support from all sampled individuals as well as the sampled institution, the institution coordinator must have status and reputation sufficient to convince others of the importance and value of participating in the study. Although the method of selection may vary greatly in line with differing cultural norms and customary ways of doing things, it is very important that there is sufficient input both from the institution and the national center in the selection of this individual to be sure he/she is capable of and willing to do the job.

The institution coordinator should be either a respected administrator or member of the teaching staff in the institution or a representative of the national center with attributes that will ensure good entry and cooperation in the institution. The institution coordinator will be responsible for the data collection, for making sure that the rate of response is as high as possible, and that the instruments are fully and adequately completed and collected. To accomplish this task, this individual may select others to assist him or her with data collection. The final responsibility of ensuring the quality of the data collection lies with the institution coordinator.

APPENDIX F:

Future Primary Teachers' OTL and Belief Indices: International Reliability and Descriptive Statistics

Exhibit F.1

OTL and Belief Indices	Reliability	Mean	*SE* (M)	*SD*	Min.	Max.
Geometry topics count		1.95	0.03	1.27	0.00	4.00
Discrete structures topics count		3.28	0.04	1.65	0.00	6.00
Continuity topics count		1.68	0.03	1.56	0.00	5.00
Probability topics count		1.30	0.02	0.73	0.00	2.00
Numbers topics count		2.68	0.01	0.68	0.00	3.00
Functions topics count		1.99	0.03	1.21	0.00	4.00
Foundations		1.71	0.02	1.04	0.00	3.00
Instruction		3.90	0.03	1.32	0.00	5.00
Class participation	0.85	10.39	0.03	1.69	5.05	14.85
Class reading	0.83	9.71	0.06	2.35	5.05	15.12
Solving problems	0.78	10.11	0.04	1.64	5.59	14.33
Instructional practice	0.89	10.98	0.06	1.99	5.03	15.28
Instructional planning	0.90	11.36	0.05	1.82	5.20	15.09
Assessment uses	0.91	11.03	0.08	2.46	4.70	15.34
Assessment practice	0.87	11.31	0.06	2.13	5.13	15.16
Social science count		2.38	0.02	0.88	0.00	3.00
Application count		4.32	0.02	0.99	0.00	5.00
Teaching for diversity	0.89	10.42	0.06	1.96	5.06	15.05
Reflection on practice	0.93	12.28	0.09	3.32	4.03	16.43
Improving practice	0.93	11.23	0.04	1.78	4.80	15.48
Connecting classroom learning	0.95	11.26	0.05	1.72	5.46	15.00
Supervising teacher reinforcement	0.94	12.41	0.05	1.86	6.00	14.95
Supervising teacher feedback quality	0.95	13.00	0.05	2.43	5.19	15.58
Program coherence	0.96	12.35	0.08	2.65	4.89	16.26
Process of inquiry	0.91	11.87	0.02	1.57	5.46	15.48
Rules and procedures	0.94	10.88	0.04	1.24	5.26	15.07
Teacher direction	0.86	9.29	0.02	0.86	4.98	14.80
Active learning	0.92	12.01	0.03	1.33	6.21	15.67
Achievement as fixed ability	0.88	9.50	0.02	1.04	5.14	15.07
Preparedness	0.87	11.78	0.06	1.93	4.20	16.17
Quality of instruction	0.97	12.63	0.07	2.57	5.03	17.35

Note: Reliabilities are unweighted and were estimated using jMetrik 2.1 (Meyer, 2011). Descriptive statistics were estimated by employing the replicate weights available in the database.

Reference

Meyer, J. P. (2011). jMetrik (2.1.0) [Computer software]. Available online at http://www.itemanalysis.com/index.php

APPENDIX G:
Future Secondary Teachers' OTL and Belief Indices: International Reliability and Descriptive Statistics

Exhibit G.1

OTL and Belief Indices	Reliability	Mean	*SE* (M)	*SD*	Min.	Max.
Geometry topics count		2.78	0.05	1.25	0.00	4.00
Discrete structures topics count		4.39	0.15	1.70	0.00	6.00
Continuity topics count		3.30	0.14	1.74	0.00	5.00
Probability topics count		1.56	0.03	0.62	0.00	2.00
Numbers topics count		2.77	0.02	0.58	0.00	3.00
Functions topics count		2.87	0.08	1.18	0.00	4.00
Foundations		1.99	0.02	0.96	0.00	3.00
Instruction		3.99	0.04	1.23	0.00	5.00
Class participation	0.83	10.54	0.08	1.62	5.05	14.85
Class reading	0.85	9.94	0.08	2.22	5.05	15.12
Solving problems	0.79	10.85	0.10	1.69	5.59	14.33
Instructional practice	0.88	11.01	0.06	1.81	5.03	15.28
Instructional planning	0.89	11.19	0.05	1.64	5.20	15.09
Assessment uses	0.90	11.01	0.07	2.30	4.70	15.34
Assessment practice	0.86	11.28	0.06	1.90	5.13	15.16
Social science count		2.39	0.02	0.87	0.00	3.00
Application count		4.24	0.03	1.05	0.00	5.00
Teaching for diversity	0.90	9.98	0.12	2.10	5.06	15.05
Reflection on practice	0.93	11.89	0.17	3.32	4.03	16.43
Improving practice	0.93	10.99	0.10	1.86	4.80	15.48
Connecting classroom learning	0.95	11.28	0.06	1.70	5.46	15.00
Supervising teacher reinforcement	0.95	12.35	0.07	1.80	6.00	14.95
Supervising teacher feedback quality	0.96	12.98	0.08	2.41	5.19	15.58
Program coherence	0.97	12.41	0.12	2.56	4.89	16.26
Process of inquiry	0.89	12.08	0.05	1.57	5.46	15.48
Rules and procedures	0.93	10.87	0.07	1.36	5.26	15.07
Teacher direction	0.86	9.44	0.04	0.95	4.98	14.80
Active learning	0.92	12.06	0.04	1.43	6.21	15.67
Achievement as fixed ability	0.88	9.66	0.06	1.05	5.14	15.07
Preparedness	0.96	11.78	0.06	1.79	4.20	16.17
Quality of instruction	0.96	12.46	0.07	2.46	5.03	17.35

Note: Reliabilities are unweighted and were estimated using jMetrik 2.1 (Meyer, 2011). Descriptive statistics were estimated by employing the replicate weights available in the database.

Reference

Meyer, J. P. (2011). jMetrik (2.1.0) [Computer software]. Available online at http://www.itemanalysis.com/index.php

APPENDIX H:
Future Primary and Secondary Teachers' and Educators' OTL and Belief Scales: International Reliabilities

Exhibit H.1

OTL and Beliefs Measures	Future Teachers		Educators
	Primary	*Secondary*	
Class participation	0.85	0.83	0.53
Class reading	0.83	0.85	0.62
Solving problems	0.78	0.79	0.71
Instructional practice	0.89	0.88	0.82
Instructional planning	0.90	0.89	0.83
Assessment uses	0.91	0.90	0.84
Assessment practice	0.87	0.86	0.65
Teaching for diversity	0.89	0.90	0.88
Reflection on practice	0.93	0.93	0.86
Improving practice	0.93	0.93	0.84
Connecting classroom learning	0.95	0.95	0.86
Supervising teacher reinforcement	0.94	0.95	n. a.
Supervising teacher feedback quality	0.95	0.96	n. a.
Program coherence	0.96	0.97	0.81
Process of inquiry	0.91	0.89	0.87
Rules and procedures	0.94	0.93	0.91
Teacher direction	0.86	0.86	0.85
Active learning	0.92	0.92	0.89
Achievement as fixed ability	0.88	0.88	0.87
Preparedness	0.87	0.96	0.91
Quality of instruction	0.97	0.96	n. a.

Note: n. a. = not applicable.

APPENDIX I:

Field Trial of the Institutional, Future Teacher, and Educator Questionnaires

Staff at the TEDS-M international study centers (ISCs) reviewed proposed items for the two future teacher questionnaires (FTQs) as well as the institutional program questionnaire (IPQ) and the educator questionnaire (EQ) in terms of how well they worked both across countries and within individual countries. This review led to improvements being made to all of the questionnaires.

Preliminary Analysis

The process of evaluating whether a set of items was appropriate for scaling and then examining the characteristics of scaled scores (using the data from the field trial) involved five steps:

1. *Carrying out cluster analyses* in order to examine the distribution of responses and complete a first test of inference.
2. *Conducting factor and reliability analyses, which included checking the patterns of missing values and the distribution of item responses.* If there was at least one missing value across the chosen items, the case was dropped through a process known as list-wise deletion. The analyses were conducted separately for the different target population samples.
3. *Completing a factor analysis to uncover the dimensionality of the measured construct (factor) during scale development.* The factor analysis results provided information such as factor loadings (i.e., the correlation between an item and a construct or factor) and variance explained (i.e., the amount of variance explained by a certain construct or factor), both of which were used to examine the intercorrelations of items and to identify items that correlated.

   A factor indicates the unidimensional measure of a construct, while a loading indicates a correlation between the item and factor. (The TEDS-M team looked for positive and relatively high factor loadings—0.50+.) Each item contributes variance, and the total variance is the sum of the item variances. As a set, the factor accounts for the variance from all items. If the factor is an efficient summary of all the items, it will explain a large percentage of the total variance. For the field trial, exploratory factor analysis (EFA) was used to check dimensionality of the scales with Likert-type items. The results from this analysis provided empirical grounds for selecting the final items for the questionnaires.

   Ideally, the magnitude of item correlations should be similar across the full set of items because this indicates that the items are equally correlated to one another. The item correlations should be relatively large, but not too large and not too small. Pairs of items with relatively large correlations suggest that the items produce the same results (measure the same constructs). Pairs of items with relatively small correlations suggest that the items produce different results (measure something different). TEDS-M reported this information to indicate the similarity of items within domains.

4. *Carrying out reliability analysis to examine the consistency of the total score and the contribution of each item to the total score, thereby providing information such as coefficient alpha and item-total correlations.* Coefficient alpha is an index of score reliability. It is the proportion of systematic variance from the observed score variance that can be explained by differences in individual attitudes, beliefs, and knowledge. This index tells us the degree to which scores are reliable, consistent, and replicable. It should be above 0.80 for research purposes (when above 0.90, scores for individuals can be used). Alpha is not an index of unidimensionality, but it may indicate the presence of a "common factor." Item-total correlations suggest correlation between an item and the total score. In other words, the correlation shows to what extent the item contributes to the total score (total measure). The coefficient alpha therefore should be positive and relatively high (0.30+).
5. *Using the information produced through the scaling process to select the field trial items that would be included in the final instruments.* Problematic items were either revised (modified) so they could be included in the main study or they were excluded from it altogether.

An example serves to illustrate how factor analysis provided empirical grounds for selecting items for the main study. Exhibit I.1 presents the results from the exploratory factor analysis (EFA) for one of the "opportunity to learn" scales—*assessment of mathematics teaching*. The results show one single latent dimension. Among the items, however, Items A and B have relatively lower factor loadings (less than 0.60). Further analysis done without those two items showed that discarding them increased the variance explained. Note the high coefficient alpha (0.908) and the higher item-total correlations. If discarding these two items did not conflict with the theory underlying the scale, the recommendation could be made for dropping both items.

Exhibit I.1: Item statistics for the opportunity to learn (OTL) scale—assessment in mathematics teaching (primary level)

Questions	With A and B	Without A	Alpha = 0.908
In your current teacher preparation program, how often did you:	*Factor loading*	*Factor loading*	*Corrected item-total correlation*
Assess low-level objectives (factual knowledge, routine procedures, and so forth)?	0.454	–	–
Assess higher-level objectives (problem-solving, critical thinking, and so forth)?	0.567	–	–
Help pupils learn how to assess their own learning?	0.738	0.707	0.672
Use standardized assessments to guide your decisions about what and how to teach?	0.793	0.789	0.747
Use classroom assessments to guide your decisions about what and how to teach?	0.796	0.815	0.767
Use assessment to give feedback to pupils about their learning?	0.814	0.834	0.785
Use assessment to give effective feedback to parents or guardians?	0.733	0.746	0.706
Analyze pupil assessment data to learn how to assess more effectively?	0.817	0.837	0.789
Percentage of variance explained	**52.5**	**62.3**	

Item Response Analysis with Rasch Model

The TEDS-M team used the Rasch (1-parameter IRT) (de Ayala, 2009) model to scale items in order to secure meaningful scale scores measuring each construct. The Rasch analysis also provided information about item fit, item difficulty (i.e., the trait or ability level associated with each item), and other measurement properties of the scale, including reliability. This process was appropriate for dichotomously scored items, such as the mathematics knowledge items (i.e., correct/incorrect), and the polytomously scored cognitive items, and for the rating-scale attitudinal items, such as the OTL and beliefs items.

For the field trial, the team used the Winstep software program (Linacre, 2009) to conduct the analyses of the attitude scales (i.e., OTL and beliefs) and the mathematics knowledge scales. The analysis for the mathematics items was done in turn for each block and booklet. Analysis also encompassed the subdomains of mathematics content knowledge (MCK) (i.e., algebra, data, geometry, and number) and mathematics pedagogy content knowledge (MPCK) (i.e., curriculum planning and enacting), as well as in total. As with the factor analysis results, the results from the Winstep analysis (e.g., item statistics, item maps, and item step graphs) provided the empirical grounds for selecting the final items for the main study.

References

de Ayala, R. J. (2009). *The theory and practice of item response theory*. New York, NY: The Guilford Press.

Linacre, J. M. (2009). Winsteps (Version 3.68) [Computer software]. Beaverton, OR: Winsteps.com.

APPENDIX J:
Model Fit Statistics for the Opportunity to Learn Scales

Tertiary-Level Mathematics

Geometry MFB1GEOM

A. Foundations of Geometry or Axiomatic Geometry (e.g., Euclidean axioms)

B. Analytic/Coordinate Geometry (e.g., equations of lines, curves, conic sections, rigid transformations or isometrics)

C. Non-Euclidean Geometry (e.g., geometry on a sphere)

D. Differential Geometry (e.g., sets that are manifolds, curvature of curves, and surfaces)

Discrete Structures and Logic MFB1DISC

F. Linear Algebra (e.g., vector spaces, matrices, dimensions, eigenvalues, eigenvectors)

G. Set Theory

H. Abstract Algebra (e.g., group theory, field theory, ring theory, ideals)

I. Number Theory (e.g., divisibility, prime numbers, structuring integers)

P. Discrete Mathematics, Graph Theory, Game Theory, Combinatorics or Boolean Algebra

S. Mathematical Logic (e.g., truth tables, symbolic logic, propositional logic, set theory, binary operations)

Continuity and Functions MFB1CONT

J. Beginning Calculus Topics (e.g., limits, series, sequences)

K. Calculus (e.g., derivatives and integrals)

L. Multivariate Calculus (e.g., partial derivatives, multiple integrals)

M. Advanced Calculus or Real Analysis or Measure Theory

N. Differential Equations (e.g., ordinary differential equations and partial differential equations)

Probability and Statistics MFB1PRST

Q. Probability

R. Theoretical or Applied Statistics

Model Fit Statistics [1]

Primary			Secondary		
CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.911	0.954	0.044	0.969	0.986	0.032

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

1 The CFI depends in large part on the average size of the correlations in the data. If the average correlation between variables is not high, then the CFI will not be very high. An acceptable model is indicated by a CFI larger than 0.93 (Byrne, 1994), but 0.85 is acceptable (Bollen, 1989). The TLI is relatively independent of sample size (Marsh, Balla, & McDonald, 1988). Values over 0.90 or 0.95 are considered acceptable (see, for example, Hu & Bentler, 1999). The RMSEA is another test of model fit. Good models are considered to have a RMSEA of 0.05 or less. Models whose RMSEA is 0.1 or more have a poor fit.

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary		
	Estimate	*SE*		*Estimate*	*SE*
GEOM by:			**GEOM** by:		
B001A	0.63	0.02	B001A	0.73	0.03
B001B	0.80	0.01	B001B	0.79	0.02
B001C	0.60	0.02	B001C	0.65	0.02
B001D	0.78	0.01	B001D	0.75	0.02
DISC by:			**DISC** by:		
B001F	0.74	0.01	B001F	0.89	0.02
B001G	0.67	0.01	B001G	0.66	0.02
B001H	0.72	0.01	B001H	0.88	0.01
B001I	0.77	0.02	B001I	0.42	0.04
B001P	0.60	0.01	B001P	0.71	0.02
B001S	0.68	0.01	B001S	0.74	0.02
CONT by:			**CONT** by:		
B001J	0.77	0.01	B001J	0.91	0.01
B001K	0.87	0.01	B001K	0.98	0.01
B001L	0.93	0.01	B001L	0.96	0.01
B001M	0.84	0.01	B001M	0.86	0.02
B001N	0.80	0.01	B001N	0.82	0.02
PRST by:			**PRST** by:		
B001Q	0.92	0.02	B001Q	0.86	0.04
B001R	0.74	0.02	B001R	0.64	0.04
DISC with:			**DISC** with:		
GEOM	0.85	0.01	GEOM	0.91	0.02
CONT with:			**CONT** with:		
GEOM	0.71	0.02	GEOM	0.83	0.02
DISC	0.74	0.01	DISC	0.88	0.01
PRST with:			**PRST** with:		
GEOM	0.61	0.02	GEOM	0.73	0.04
DISC	0.66	0.02	DISC	0.73	0.04
CONT	0.42	0.02	CONT	0.62	0.04

Note: All p-values associated with the loading estimates are less than 0.005.

School-Level Mathematics

Numbers, Measurement, and Geometry MFB2SLMN

A. Numbers (e.g., whole numbers, fractions, decimals, integer, rational, and real numbers; number concepts; number theory; estimation; ratio and proportionality)

B. Measurement (e.g., measurement units; computations and properties of length, perimeter, area, and volume; estimation and error)

C. Geometry (e.g., 1-D and 2-D coordinate geometry, Euclidean geometry, transformational geometry, congruence and similarity, constructions with straightedge and compass, 3-D geometry, vector geometry)

Functions Probability Calculus MFB2SLMF

A. Functions, Relations, and Equations (e.g., algebra, trigonometry, analytic geometry)

B. Data Representation, Probability, and Statistics

C. Calculus (e.g., infinite processes, change, differentiation, integration)

D. Validation, Structuring, and Abstracting (e.g., Boolean algebra, mathematical induction, logical connectives, sets, groups, fields, linear space, isomorphism, homomorphism)

Model Fit Statistics

Primary			Secondary		
CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.97	0.973	0.057	0.892	0.846	0.085

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary		
	Estimate	*SE*		*Estimate*	*SE*
SLMN by:			**SLMN** by:		
B002A	0.99	0.01	B002A	0.95	0.03
B002B	0.92	0.01	B002B	0.86	0.03
B002C	0.86	0.01	B002C	0.82	0.03
SLMF by:			**SLMF** by:		
B002D	0.90	0.01	B002D	0.82	0.02
B002E	0.72	0.01	B002E	0.63	0.03
B002F	0.62	0.02	B002F	0.83	0.02
B002G	0.60	0.02	B002G	0.85	0.02
SLMF with:			**SLMF** with:		
SLMN	0.84	0.01	SLMN	0.49	0.03

Note: All *p*-values associated with the loading estimates are less than 0.005.

Mathematics Education Pedagogy

Foundations MFB4FOUN

A. Foundations of Mathematics (e.g., mathematics and philosophy, mathematics epistemology, history of mathematics)

B. Context of Mathematics Education (e.g., role of mathematics in society, gender/ethnic aspects of mathematics achievement)

C. Development of Mathematics Ability and Thinking (e.g., theories of mathematics ability and thinking; developing mathematical concepts; reasoning, argumentation, and proving; abstracting and generalizing; carrying out procedures and algorithms; application; modeling).

Instruction MFB4INST

A. Mathematics Instruction (e.g., representation of mathematics content and concepts, teaching methods, analysis of mathematical problems and solutions, problem-posing strategies, teacher–student interaction)

B. Developing Teaching Plans (e.g., selection and sequencing the mathematics content; studying and selecting textbooks and instructional materials)

C. Mathematics Teaching: Observation, Analysis, and Reflection

D. Mathematics Standards and Curriculum

E. Affective Issues in Mathematics (e.g., beliefs, attitudes, mathematics anxiety)

Model Fit Statistics

Primary			Secondary		
CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.969	0.971	0.036	0.966	0.963	0.033

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary		
	Estimate	*SE*		*Estimate*	*SE*
FOUN by:			**FOUN** by:		
B004A	0.54	0.02	B004A	0.51	0.03
B004B	0.77	0.02	B004B	0.72	0.02
B004C	0.80	0.02	B004C	0.72	0.03
INST by:			**INST** by:		
B004D	0.80	0.02	B004D	0.77	0.03
B004E	0.75	0.01	B004E	0.74	0.02
B004F	0.86	0.01	B004F	0.82	0.02
B004G	0.80	0.01	B004G	0.76	0.02
B004H	0.73	0.02	B004H	0.68	0.02
INST with:			**INST** with:		
FOUN	0.69	0.02	FOUN	0.68	0.03

Note: All p-values associated with the loading estimates are less than 0.005.

Mathematics Education Pedagogy

Class Participation MFB5PART

B. Ask questions during class time
C. Participate in a whole-class discussion
D. Make presentations to the rest of the class
E. Teach a class session using methods of my own choice
F. Teach a class session using methods demonstrated by the instructor

Class Reading MFB5READ

H. Read about research on mathematics
I. Read about research on mathematics education
J. Read about research on teaching and learning
K. Analyze examples of teaching (e.g., film, video, transcript of lesson)

Solving Problems MFB5SOLV

L. Write mathematical proofs
M. Solve problems in applied mathematics
N. Solve a given mathematics problem using multiple strategies
O. Use computers or calculators to solve mathematics problems

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.922	0.964	0.066	0.941	0.966	0.058	0.868	0.858	0.182

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
PART by:			**PART** by:			**PART** by		
B005B	0.73	0.01	B005B	0.68	0.01	I001B	0.43	0.03
B005C	0.81	0.01	B005C	0.75	0.01	I001C	0.64	0.02
B005D	0.67	0.01	B005D	0.63	0.01	I001D	0.74	0.01
B005E	0.76	0.01	B005E	0.74	0.01	I001E	0.94	0.01
B005F	0.75	0.01	B005F	0.72	0.01	I001F	0.77	0.01
READ by:			**READ** by:			**READ** by:		
B005H	0.90	0.01	B005H	0.86	0.01	I001H	0.95	0.01
B005I	0.95	0.01	B005I	0.95	0.01	I001I	0.85	0.01
B005J	0.80	0.01	B005J	0.85	0.01	I001J	0.49	0.02
B005K	0.60	0.01	B005K	0.56	0.02	I001K	0.49	0.02
SOLV by:			**SOLV** by:			**SOLV** by:		
B005L	0.58	0.01	B005L	0.58	0.02	I001L	0.87	0.01
B005M	0.75	0.01	B005M	0.81	0.01	I001M	0.94	0.00
B005N	0.86	0.01	B005N	0.84	0.01	I001N	0.96	0.00
B005O	0.56	0.01	B005O	0.53	0.02	I001O	0.83	0.01
READ with:			**READ** with			**READ** with		
PART	0.60	0.01	PART	0.57	0.02	PART	0.65	0.02
SOLV with:			**SOLV** with:			**SOLV** with:		
PART	0.46	0.01	PART	0.30	0.03	PART	-0.14	0.03
READ	0.56	0.01	READ	0.49	0.02	READ	0.68	0.01

Note: All *p*-values associated with the loading estimates are less than 0.005.

Mathematics Education Pedagogy

Instructional Practice MFB6IPRA

L. Explore how to apply mathematics to real-world problems
A. Explore mathematics as the source for real-world problems
Q. Learn how to explore multiple solution strategies with pupils
R. Learn how to show why a mathematics procedure works
T. Make distinctions between procedural and conceptual knowledge when teaching mathematics concepts and operations to pupils
Z. Integrate mathematical ideas from across areas of mathematics

Instructional Planning MFB6IPLA

A. Accommodate a wide range of abilities in each lesson
G. Create learning experiences that make the central concepts of subject matter meaningful to pupils
H. Create projects that motivate all pupils to participate
I. Deal with learning difficulties so that specific pupil outcomes are accomplished
J. Develop games or puzzles that provide instructional activities at a high interest level
K. Develop instructional materials that build on pupils' experiences, interests, and abilities
X. Use pupils' misconceptions to plan instruction

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.921	0.981	0.063	0.918	0.975	0.059	0.946	0.955	0.05

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
IPRA by:			**IPRA** by:			**IPRA** by:		
B006L	0.85	0.01	B006L	0.80	0.01	G002C	0.85	0.02
B006N	0.76	0.01	B006N	0.66	0.01	G002E	0.87	0.01
B006Q	0.80	0.01	B006Q	0.78	0.01	G002F	0.75	0.02
B006R	0.79	0.01	B006R	0.75	0.01	G002G	0.68	0.02
B006T	0.75	0.01	B006T	0.74	0.01	G002H	0.75	0.02
B006Z	0.79	0.01	B006Z	0.74	0.01	G002I	0.69	0.02
IPLA by:			**IPLA** by:			**IPLA** by:		
B006A	0.68	0.01	B006A	0.63	0.01	I003A	0.57	0.03
B006G	0.82	0.01	B006G	0.77	0.01	I003E	0.73	0.03
B006H	0.80	0.01	B006H	0.73	0.01	I003F	0.69	0.02
B006I	0.80	0.01	B006I	0.78	0.01	I003G	0.76	0.02
B006J	0.80	0.01	B006J	0.75	0.01	I003H	0.73	0.02
B006K	0.84	0.01	B006K	0.80	0.01	I003I	0.82	0.02
B006X	0.67	0.01	B006X	0.62	0.01	I003P	0.58	0.02
IPLA with:			**IPLA** with:			**IPLA** with:		
B005L	0.58	0.01	B005L	0.58	0.02	I001L	0.87	0.01

Note: All p-values associated with the loading estimates are less than 0.005.

Mathematics Education Pedagogy

Assessment Uses MFB6AUSE
O. Give useful and timely feedback to pupils about their learning
P. Help pupils learn how to assess their own learning
U. Use assessment to give effective feedback to parents or guardians
V. Use assessment to give feedback to pupils about their learning
W. Use classroom assessments to guide your decisions about what and how to teach

Assessment Practice MFB6APRA
A. Analyze and use national or state standards or frameworks for school mathematics
B. Analyze pupil assessment data to learn how to assess more effectively
C. Assess higher-level goals (e.g., problem-solving, critical thinking)
D. Assess low-level objectives (factual knowledge, routine procedures, and so forth)
F. Build on pupils' existing mathematics knowledge and thinking skills

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.955	0.984	0.072	0.928	0.977	0.067	0.911	0.924	0.089

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
AUSE by:			**AUSE** by:			**AUSE** by:		
B006O	0.81	0.01	B006O	0.82	0.01	I003J	0.87	0.01
B006P	0.78	0.01	B006P	0.80	0.01	I003K	0.85	0.01
B006U	0.84	0.01	B006U	0.82	0.01	I003M	0.70	0.02
B006V	0.92	0.00	B006V	0.91	0.01	I003N	0.88	0.01
B006W	0.87	0.00	B006W	0.80	0.01	I003O	0.84	0.01
APRA by:			**APRA** by:			**APRA** by:		
B006B	0.68	0.01	B006B	0.63	0.02	I003B	0.85	0.02
B006C	0.84	0.01	B006C	0.82	0.01	I003C	0.78	0.02
B006D	0.83	0.01	B006D	0.82	0.01	I003D	0.75	0.02
B006E	0.78	0.01	B006E	0.73	0.01	G002A	0.53	0.04
B006F	0.78	0.01	B006F	0.75	0.01	G002B	0.58	0.04
APRA with:			**APRA** with:			**APRA** with:		
AUSE	0.78	0.01	AUSE	0.78	0.01	AUSE	0.74	0.03

Note: All p-values associated with the loading estimates are less than 0.005.

Education Pedagogy

Social Science MFB7EPSS

A. History of Education and Educational Systems (e.g., historical development of the national system, development of international systems)

B. Philosophy of Education (e.g., ethics, values, theory of knowledge, legal issues)

C. Sociology of Education (e.g., purpose and function of education in society, organization of current education systems, education and social conditions, diversity, educational reform)

Application MFB7EPAP

A. Educational Psychology (e.g., motivational theory, child development, learning theory)

B. Theories of Schooling (e.g., goals of schooling, teacher's role, curriculum theory and development, didactic/teaching models, teacher–pupil relations, school administration and leadership)

C. Methods of Educational Research (e.g., read, interpret, and use education research; theory and practice of action research)

D. Assessment and Measurement: Theory and Practice

H. Knowledge of Teaching (e.g., knowing how to teach pupils of different backgrounds, using resources to support instruction, managing classrooms, communicating with parents)

Model Fit Statistics

Primary			Secondary		
CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.946	0.943	0.031	0.977	0.974	0.024

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary		
	Estimate	*SE*		*Estimate*	*SE*
EPSS by:			**EPSS** by:		
B007A	0.63	0.02	B007A	0.58	0.03
B007B	0.72	0.02	B007B	0.73	0.02
B007C	0.78	0.02	B007C	0.77	0.03
EPAP by:			**EPAP** by:		
B007D	0.46	0.04	B007D	0.68	0.04
B007E	0.71	0.02	B007E	0.71	0.03
B007F	0.78	0.02	B007F	0.73	0.02
B007G	0.61	0.02	B007G	0.66	0.03
B007H	0.69	0.02	B007H	0.74	0.02
EPAP with:			**EPAP** with:		
EPSS	0.73	0.02	EPSS	0.79	0.03

Note: All p-values associated with the loading estimates are less than 0.005.

Education Pedagogy

Teaching for Diversity MFB8DVRS

A. Develop specific strategies for teaching students with behavioral and emotional problems
B. Develop specific strategies and curriculum for teaching pupils with learning disabilities
C. Develop specific strategies and curriculum for teaching gifted pupils
D. Develop specific strategies and curriculum for teaching pupils from diverse cultural backgrounds
E. Accommodate the needs of pupils with physical disabilities in your classroom
F. Work with children from poor or disadvantaged backgrounds

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.959	0.974	0.087	0.953	0.98	0.082	0.964	0.97	0.09

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
DVRS by:			**DVRS** by:			**DVRS** by:		
B008A	0.82	0.01	B008A	0.84	0.01	H002A	0.82	0.01
B008B	0.86	0.01	B008B	0.87	0.01	H002B	0.87	0.01
B008C	0.75	0.01	B008C	0.73	0.01	H002C	0.72	0.02
B008D	0.74	0.01	B008D	0.79	0.01	H002D	0.79	0.01
B008E	0.73	0.01	B008E	0.80	0.01	H002E	0.75	0.02
B008F	0.71	0.01	B008F	0.75	0.01	H002F	0.75	0.02

Note: All p-values associated with the loading estimates are less than 0.005.

Education Pedagogy

Teaching for Reflection on Practice MFB8REFL

G. Use teaching standards and codes of conduct to reflect on your teaching
H. Develop strategies to reflect upon the effectiveness of your teaching
L. Develop strategies to reflect upon your professional knowledge
J. Develop strategies to identify your learning needs

Improving Practice MFB9IMPR

E. Develop and test new teaching practices
F. Set appropriately challenging learning expectations for pupils
G. Learn how to use findings from research to improve knowledge and practice
H. Connect learning across subject areas
I. Study ethical standards and codes of conduct expected of teachers
J. Create methods to enhance pupils' confidence and self-esteem
K. Identify opportunities for changing existing schooling practices
L. Identify appropriate resources needed for teaching

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.973	0.993	0.053	0.967	0.991	0.053	0.977	0.981	0.053

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
REFL by:			**REFL** by:			**REFL** by:		
B008G	0.82	0.01	B008G	0.83	0.01	H002G	0.83	0.01
B008H	0.92	0.00	B008H	0.91	0.01	H002H	0.89	0.01
B008I	0.96	0.00	B008I	0.95	0.00	H002I	0.89	0.01
B008J	0.91	0.00	B008J	0.91	0.01	H002J	0.88	0.01
IMPR by:			**IMPR** by:			**IMPR** by:		
B009E	0.68	0.01	B009E	0.72	0.01	H001E	0.65	0.03
B009F	0.81	0.01	B009F	0.79	0.01	H001F	0.72	0.02
B009G	0.72	0.01	B009G	0.78	0.01	H001G	0.54	0.03
B009H	0.71	0.01	B009H	0.76	0.01	H001H	0.66	0.02
B009I	0.76	0.01	B009I	0.77	0.01	H001I	0.70	0.02
B009J	0.82	0.01	B009J	0.83	0.01	H001J	0.76	0.02
B009K	0.69	0.01	B009K	0.72	0.01	H001K	0.67	0.02
B009L	0.68	0.01	B009L	0.68	0.01	H001L	0.73	0.02
IMPR with:			**IMPR** with:			**IMPR** with:		
REFL	0.81	0.01	REFL	0.81	0.01	REFL	0.78	0.02

Note: All p-values associated with the loading estimates are less than 0.005.

School Experience

Connecting Classroom Learning to Practice MFB13CLP

A. Observe models of the teaching strategies you were learning in your <courses>
B. Practice theories for teaching mathematics that you were learning in your <courses>
C. Complete assessment tasks that asked you to show how you were applying ideas you were learning in your <courses>
D. Receive feedback about how well you had implemented teaching strategies you were learning in your <courses>
E. Collect and analyze evidence about pupil learning as a result of your teaching methods
F. Test out findings from educational research about difficulties pupils have in learning in your <courses>
G. Develop strategies to reflect upon your professional knowledge
H. Demonstrate that you could apply the teaching methods you were learning in your <courses>

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.953	0.978	0.064	0.951	0.976	0.065	0.961	0.957	0.061

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
CLP by:			**CLP** by:			**CLP** by:		
B013A	0.67	0.01	B013A	0.70	0.01	I002A	0.65	0.02
B013B	0.73	0.01	B013B	0.72	0.01	I002B	0.63	0.03
B013C	0.81	0.01	B013C	0.80	0.01	I002C	0.64	0.02
B013D	0.76	0.01	B013D	0.71	0.01	I002D	0.75	0.02
B013E	0.78	0.01	B013E	0.78	0.01	I002E	0.78	0.02
B013F	0.76	0.01	B013F	0.79	0.01	I002F	0.72	0.02
B013G	0.68	0.01	B013G	0.73	0.01	I002G	0.60	0.02
B013H	0.75	0.01	B013H	0.76	0.01	I002H	0.77	0.02

Note: All p-values associated with the loading estimates are less than 0.005.

School Experience

Supervising Teacher Reinforcement of University Goals for Practicum MFB14STR

A. I had a clear understanding of what my school-based <supervising teacher/mentor/instructors> expected of me as a teacher in order to pass the <field experiences/practicum>.

B. My school-based <supervising teacher/mentor/instructors> valued the ideas and approaches I brought from my <university/college> teacher education program.

C. My school-based < supervising teacher/mentor/instructors > used criteria/standards provided by my <university/college> when reviewing my lessons with me.

D. I learned the same criteria or standards for good teaching in my <courses> and in my <field experiences/practicum>.

E. In my <field experience/practicum> I had to demonstrate to my supervising teacher that I could teach according to the same criteria/standards used in my <university/college> <courses>.

Supervising Teacher Feedback Quality MFB14STF

F. The feedback I received from my <supervising teacher/mentor/instructors> helped me improve my understanding of pupils.

G. The feedback I received from my <supervising teacher/mentor/instructors> helped me improve my teaching methods.

H. The feedback I received from my <supervising teacher/mentor/instructors> helped me improve my understanding of the curriculum.

I. The feedback I received from my <supervising teacher/mentor/instructors> helped me improve my knowledge of mathematics content.

Model Fit Statistics

Primary			Secondary		
CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.968	0.982	0.057	0.968	0.981	0.059

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary		
	Estimate	*SE*		*Estimate*	*SE*
STR by:			**STR** by:		
B014A	0.66	0.01	B014A	0.65	0.02
B014B	0.78	0.01	B014B	0.75	0.02
B014C	0.80	0.01	B014C	0.77	0.01
B014D	0.74	0.01	B014D	0.73	0.01
B014E	0.74	0.01	B014E	0.76	0.01
STF by:			**STF** by:		
B014F	0.89	0.01	B014F	0.90	0.01
B014G	0.93	0.01	B014G	0.93	0.01
B014H	0.87	0.01	B014H	0.85	0.01
B014I	0.77	0.01	B014I	0.79	0.01
STF with:			**STF** with:		
STR	0.72	0.01	STR	0.69	0.02

Note: All *p*-values associated with the loading estimates are less than 0.005.

Program Coherence

Program Coherence MFB15COH

A. Each stage of the program seemed to be planned to meet the main needs I had at that stage of my preparation.
B. Later <courses> in the program built on what was taught in earlier <courses> in the program.
C. The program was organized in a way that covered what I needed to learn to become an effective teacher.
D. The <courses> seemed to follow a logical sequence of development in terms of content and topics.
E. Each of my <courses> was clearly designed to prepare me to meet a common set of explicit standard expectations for beginning teachers.
F. There were clear links between most of the <courses> in my teacher education program.

Model Fit Statistics

Primary			Secondary			Educator		
CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
0.99	0.995	0.058	0.992	0.996	0.049	0.994	0.995	0.049

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

Factor Loadings (Estimate), Loading SEs, and Factor Correlations

Primary			Secondary			Educator		
	Estimate	*SE*		*Estimate*	*SE*		*Estimate*	*SE*
COH by:			**COH** by:			**COH** by:		
B015A	0.84	0.01	B015A	0.83	0.01	J001A	0.83	0.01
B015B	0.78	0.01	B015B	0.74	0.01	J001B	0.78	0.01
B015C	0.89	0.01	B015C	0.87	0.01	J001C	0.89	0.01
B015D	0.88	0.01	B015D	0.86	0.01	J001D	0.84	0.01
B015E	0.88	0.01	B015E	0.87	0.01	J001E	0.88	0.01
B015F	0.85	0.01	B015F	0.84	0.01	J001F	0.84	0.01

Note: All p-values associated with the loading estimates are less than 0.005.

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APPENDIX K:

Model Fit Statistics for the Opportunity to Learn Scales for Future Teachers and Educators by Country

Exhibit K.1

	Primary Future Teachers			Secondary Future Teachers			Educators		
	CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
Tertiary Mathematics									
Q1_Chile	0.877	0.886	0.053	0.889	0.894	0.046			
Q1_Chinese Taipei	0.824	0.845	0.104	–	–	–			
Q1_Georgia	0.942	0.950	0.034	0.736	0.824	0.120			
Q1_Germany	0.986	0.988	0.044	0.912	0.931	0.100			
Q1_Malaysia	0.965	0.978	0.050	0.711	0.761	0.129			
Q1_Norway	0.924	0.944	0.064	0.863	0.886	0.071			
Q1_Philippines	0.888	0.888	0.072	0.804	0.788	0.050			
Q1_Poland	0.971	0.982	0.059	–	–	–			
Q1_Russian Fed.	0.907	0.877	0.064	0.928	0.962	0.046			
Q1_Singapore	0.966	0.978	0.070	0.957	0.967	0.088			
Q1_Spain	0.913	0.917	0.057	–	–	–			
Q1_Switzerland	0.900	0.925	0.058	–	–	–			
Q1_Thailand	0.803	0.813	0.054	–	–	–			
Q1_United States	0.893	0.944	0.071	0.964	0.974	0.049			
School Mathematics									
Q2_Chile	0.913	0.870	0.067	0.994	0.991	0.016			
Q2_Chinese Taipei	0.968	0.956	0.076	0.938	0.945	0.092			
Q2_Georgia	0.940	0.905	0.067	0.746	0.704	0.192			
Q2_Germany	0.996	0.995	0.042	0.866	0.832	0.075			
Q2_Malaysia	0.976	0.972	0.152	0.999	0.999	0.008			
Q2_Norway	0.949	0.942	0.029	0.825	0.803	0.080			
Q2_Philippines	0.974	0.974	0.089	–	–	–			
Q2_Poland	0.956	0.950	0.137	0.858	0.763	0.125			
Q2_Russian Fed.	0.898	0.824	0.057	0.973	0.964	0.072			
Q2_Singapore	0.959	0.945	0.081	0.973	0.969	0.081			
Q2_Spain	0.968	0.955	0.039	–	–	–			
Q2_Switzerland	0.991	0.989	0.029	0.566	0.518	0.164			
Q2_Thailand	0.905	0.893	0.108	0.912	0.912	0.101			
Q2_United States	0.981	0.974	0.060	0.861	0.778	0.193			
FOUN/INST									
Q4_Chile	0.970	0.965	0.039	0.926	0.926	0.069			
Q4_Chinese Taipei	0.951	0.949	0.060	0.963	0.955	0.051			
Q4_Georgia	0.968	0.964	0.037	0.985	0.982	0.040			
Q4_Germany	0.994	0.993	0.034	0.996	0.994	0.020			
Q4_Malaysia	0.987	0.988	0.032	0.989	0.992	0.066			
Q4_Norway	0.898	0.886	0.080	0.832	0.821	0.076			
Q4_Philippines	0.981	0.978	0.032	0.987	0.988	0.026			
Q4_Poland	0.967	0.962	0.044	0.891	0.844	0.063			
Q4_Russian Fed.	0.963	0.961	0.041	0.975	0.972	0.040			
Q4_Singapore	0.967	0.960	0.044	0.920	0.892	0.055			
Q4_Spain	0.946	0.942	0.053	–	–	–			
Q4_Switzerland	0.928	0.915	0.056	–	–	–			
Q4_Thailand	0.981	0.978	0.037	0.940	0.935	0.060			
Q4_Unoted States	0.945	0.938	0.053	0.980	0.975	0.024			

Exhibit K.1 (contd.)

	Primary Future Teachers			Secondary Future Teachers			Educators		
	CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
PART/READ/SOLV									
Q5_Chile	0.892	0.930	0.118	0.903	0.938	0.121	0.989	0.989	0.121
Q5_Chinese Taipei	0.941	0.961	0.099	0.959	0.963	0.101	0.828	0.841	0.280
Q5_Georgia	0.812	0.837	0.181	0.862	0.876	0.187			
Q5_Germany	0.974	0.983	0.063	0.958	0.965	0.061	0.931	0.920	0.167
Q5_Malaysia	0.953	0.972	0.120	0.918	0.948	0.175	0.941	0.944	0.153
Q5_Norway	0.883	0.875	0.154	0.846	0.855	0.145			
Q5_Philippines	0.949	0.966	0.063	0.943	0.973	0.055	0.962	0.966	0.182
Q5_Poland	0.899	0.915	0.100	0.924	0.937	0.117	–	–	–
Q5_Russian Fed.	0.941	0.957	0.086	0.944	0.962	0.111	0.788	0.799	0.260
Q5_Singapore	0.955	0.967	0.091	0.907	0.926	0.115			
Q5_Spain	–	–	–	–	–	–	0.950	0.947	0.191
Q5_Switzerland	0.914	0.919	0.088	0.833	0.839	0.126	0.916	0.920	0.142
Q5_Thailand	0.967	0.977	0.085	0.973	0.977	0.088	0.964	0.969	0.198
Q5_United States	0.905	0.940	0.102	0.908	0.937	0.078	–	–	–
IPRA/IPLA									
Q6a_Chile	0.859	0.955	0.120	0.929	0.975	0.102	0.961	0.970	0.076
Q6a_Chinese Taipei	0.856	0.946	0.118	0.858	0.936	0.123	0.929	0.924	0.097
Q6a_Georgia	0.865	0.919	0.117	0.929	0.975	0.102			
Q6a_Germany	0.926	0.973	0.097	0.868	0.940	0.085	0.889	0.874	0.090
Q6a_Malaysia	0.901	0.968	0.131	0.923	0.974	0.117	0.979	0.985	0.093
Q6a_Norway	0.882	0.939	0.109	0.858	0.919	0.099			
Q6a_Philippines	0.936	0.968	0.062	0.955	0.976	0.065	0.984	0.988	0.050
Q6a_Poland	0.908	0.966	0.096	0.951	0.977	0.089	0.931	0.927	0.093
Q6a_Russian Fed.	0.939	0.975	0.064	0.933	0.978	0.068	0.937	0.944	0.060
Q6a_Singapore	0.888	0.954	0.114	0.873	0.947	0.103			
Q6a_Spain	0.893	0.967	0.109	–	–	–	0.927	0.950	0.090
Q6a_Switzerland	0.893	0.944	0.087	0.960	0.979	0.076	0.959	0.951	0.069
Q6a_Thailand	0.934	0.977	0.087	0.909	0.962	0.101	0.934	0.954	0.088
Q6a_United States	0.938	0.977	0.088	0.945	0.976	0.077	–	–	–
AUSE/APRA									
Q6b_Chile	0.952	0.977	0.102	0.937	0.972	0.124	0.935	0.935	0.122
Q6b_Chinese Taipei	0.922	0.956	0.097	0.919	0.956	0.096	–	–	–
Q6b_Georgia	0.764	0.789	0.189	0.932	0.950	0.134			
Q6b_Germany	0.952	0.976	0.145	0.971	0.976	0.088	–	–	–
Q6b_Malaysia	0.931	0.959	0.172	0.952	0.976	0.119	0.973	0.973	0.120
Q6b_Norway	0.946	0.960	0.103	0.943	0.964	0.101			
Q6b_Philippines	0.970	0.981	0.061	0.963	0.973	0.061	–	–	–
Q6b_Poland	0.954	0.971	0.129	0.941	0.969	0.134	0.958	0.964	0.110
Q6b_Russian Fed.	0.962	0.979	0.075	0.960	0.981	0.073	0.974	0.974	0.068
Q6b_Singapore	0.929	0.951	0.158	0.911	0.954	0.118			
Q6b_Spain	0.945	0.971	0.129	–	–	–	0.974	0.971	0.079
Q6b_Switzerland	0.930	0.959	0.113	0.896	0.915	0.131	–	–	–
Q6b_Thailand	0.949	0.977	0.100	0.948	0.976	0.111	0.958	0.958	0.085
Q6b_United States	0.957	0.984	0.086	0.923	0.982	0.080	–	–	–

Exhibit K.1 (contd.)

	Primary Future Teachers			Secondary Future Teachers			Educators		
	CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
EPSS/EPAP									
Q7_Chile	0.949	0.949	0.038	1.000	1.022	0.000			
Q7_Chinese Taipei	0.953	0.933	0.042	–	–	–			
Q7_Georgia	0.989	0.987	0.021	1.000	1.066	0.000			
Q7_Germany	0.931	0.916	0.035	0.855	0.815	0.064			
Q7_Malaysia	0.996	0.995	0.016	0.934	0.928	0.088			
Q7_Norway	0.975	0.975	0.035	0.982	0.981	0.034			
Q7_Philippines	0.934	0.934	0.035	0.906	0.906	0.043			
Q7_Poland	0.962	0.959	0.046	0.946	0.930	0.065			
Q7_Russian Fed.	0.982	0.984	0.017	1.000	1.001	0.000			
Q7_Singapore	0.994	0.992	0.028	0.532	0.532	0.181			
Q7_Spain	0.894	0.879	0.065	–	–	–			
Q7_Switzerland	1.000	1.008	0.000	0.960	0.951	0.044			
Q7_Thailand	0.928	0.961	0.034	0.985	0.982	0.020			
Q7_United States	0.979	0.979	0.029	0.929	0.910	0.050			
Diversity									
Q8_Chile	0.954	0.971	0.132	0.977	0.985	0.111	0.980	0.984	0.130
Q8_Chinese Taipei	0.980	0.982	0.132	0.972	0.975	0.111	0.961	0.953	0.241
Q8_Georgia	0.944	0.944	0.158	0.966	0.983	0.142			
Q8_Germany	0.912	0.912	0.116	0.920	0.908	0.108	0.942	0.942	0.198
Q8_Malaysia	0.965	0.980	0.166	0.961	0.978	0.145	0.975	0.986	0.150
Q8_Norway	0.967	0.971	0.120	0.941	0.949	0.140			
Q8_Philippines	0.955	0.966	0.090	0.935	0.954	0.128	0.966	0.972	0.131
Q8_Poland	0.973	0.980	0.097	0.975	0.979	0.114	0.952	0.962	0.199
Q8_Russian Fed.	0.956	0.963	0.116	0.963	0.974	0.121	0.951	0.958	0.145
Q8_Singapore	0.968	0.977	0.151	0.959	0.964	0.160			
Q8_Spain	0.946	0.969	0.141	–	–	–	0.942	0.962	0.214
Q8_Switzerland	0.943	0.943	0.149	0.956	0.939	0.183	0.902	0.902	0.303
Q8_Thailand	0.945	0.953	0.183	0.955	0.961	0.168	0.975	0.986	0.127
Q8_United States	0.972	0.983	0.101	0.974	0.985	0.094	–	–	–
REFL/IMPR									
Q89_Chile	0.969	0.990	0.094	0.964	0.989	0.098	0.959	0.972	0.093
Q89_Chinese Taipei	0.977	0.989	0.078	0.977	0.989	0.107	0.964	0.964	0.088
Q89_Georgia	0.935	0.970	0.128	0.942	0.950	0.146			
Q89_Germany	0.940	0.968	0.079	0.959	0.971	0.064	0.929	0.929	0.123
Q89_Malaysia	0.974	0.993	0.102	0.977	0.992	0.109	0.980	0.991	0.078
Q89_Norway	0.974	0.986	0.071	0.968	0.986	0.065			
Q89_Philippines	0.979	0.989	0.053	0.977	0.992	0.056	0.987	0.991	0.058
Q89_Poland	0.974	0.992	0.080	0.977	0.990	0.110	0.941	0.975	0.120
Q89_Russian Fed.	0.965	0.981	0.084	0.956	0.986	0.087	0.945	0.968	0.078
Q89_Singapore	0.978	0.992	0.085	0.973	0.990	0.084			
Q89_Spain	0.967	0.990	0.074	–	–	–	0.953	0.964	0.085
Q89_Switzerland	0.950	0.970	0.073	0.942	0.962	0.094	0.891	0.926	0.114
Q89_Thailand	0.969	0.991	0.080	0.974	0.990	0.082	0.971	0.984	0.122
Q89_United States	0.963	0.987	0.074	0.974	0.985	0.070	–	–	–

Exhibit K.1 (contd.)

	Primary Future Teachers			Secondary Future Teachers			Educators		
	CFI	TLI	RMSEA	CFI	TLI	RMSEA	CFI	TLI	RMSEA
Connecting to Practice									
Q13_Chile	0.960	0.983	0.105	0.979	0.991	0.082	0.907	0.925	0.171
Q13_Chinese Taipei	0.926	0.966	0.132	0.900	0.953	0.159	0.922	0.948	0.172
Q13_Georgia	0.975	0.988	0.093	0.928	0.937	0.245			
Q13_Germany	0.946	0.946	0.059	0.914	0.938	0.059	0.895	0.863	0.092
Q13_Malaysia	0.953	0.975	0.138	0.975	0.987	0.098	0.977	0.982	0.129
Q13_Norway	0.935	0.948	0.091	0.956	0.964	0.066			
Q13_Philippines	0.951	0.951	0.101	0.986	0.989	0.053	0.956	0.970	0.116
Q13_Poland	0.912	0.903	0.124	0.879	0.925	0.152	0.949	0.949	0.110
Q13_Russian Fed.	0.932	0.941	0.088	0.911	0.948	0.115	0.940	0.964	0.089
Q13_Singapore	0.940	0.962	0.107	0.915	0.940	0.124			
Q13_Spain	0.959	0.970	0.086	–	–	–	0.951	0.965	0.098
Q13_Switzerland	0.950	0.961	0.075	0.932	0.947	0.099	0.920	0.925	0.093
Q13_Thailand	0.931	0.963	0.106	0.951	0.966	0.103	0.952	0.976	0.186
Q13_United States	0.962	0.983	0.076	0.973	0.984	0.074	–	–	–
Supervising Teacher									
Q14_Chile	0.972	0.982	0.105	0.982	0.991	0.076			
Q14_Chinese Taipei	0.991	0.993	0.064	0.998	0.998	0.036			
Q14_Georgia	0.993	0.996	0.062	0.997	0.997	0.073			
Q14_Germany	0.973	0.977	0.064	0.946	0.950	0.074			
Q14_Malaysia	0.980	0.990	0.121	0.981	0.993	0.099			
Q14_Norway	0.955	0.958	0.109	0.960	0.965	0.086			
Q14_Philippines	0.981	0.982	0.053	0.996	0.997	0.037			
Q14_Poland	0.978	0.986	0.059	0.987	0.993	0.058			
Q14_Russian Fed.	0.978	0.978	0.053	0.980	0.988	0.060			
Q14_Singapore	0.957	0.974	0.130	0.968	0.977	0.125			
Q14_Spain	0.959	0.964	0.080	–	–	–			
Q14_Switzerland	0.871	0.878	0.116	0.986	0.986	0.052			
Q14_Thailand	0.900	0.933	0.111	0.916	0.942	0.095			
Q14_United States	0.973	0.985	0.074	0.980	0.982	0.062			
Coherence									
Q15_Chile	0.988	0.994	0.078	0.975	0.986	0.125	0.990	0.991	0.077
Q15_Chinese Taipei	0.949	0.957	0.139	0.907	0.893	0.186	0.959	0.959	0.169
Q15_Georgia	0.997	0.998	0.049	0.962	0.962	0.182			
Q15_Germany	0.976	0.985	0.071	0.960	0.960	0.074	0.983	0.986	0.082
Q15_Malaysia	0.984	0.992	0.133	0.993	0.996	0.089	0.958	0.958	0.197
Q15_Norway	0.978	0.981	0.080	0.955	0.960	0.117			
Q15_Philippines	0.983	0.980	0.075	0.982	0.988	0.080	0.995	0.996	0.055
Q15_Poland	0.980	0.986	0.093	0.992	0.995	0.057	0.975	0.986	0.105
Q15_Russian Fed.	0.983	0.988	0.049	0.990	0.992	0.056	0.981	0.986	0.067
Q15_Singapore	0.989	0.992	0.116	0.990	0.994	0.075			
Q15_Spain	0.972	0.983	0.088	–	–	–	0.991	0.994	0.054
Q15_Switzerland	0.954	0.948	0.089	0.995	0.995	0.043	–	–	–
Q15_Thailand	0.980	0.982	0.097	0.973	0.973	0.138	0.986	0.988	0.118
Q15_United States	0.990	0.995	0.074	0.993	0.994	0.058	–	–	–

Note: CFI (Comparative Fit Scale), TLI (Tucker Lewis Scale), RMSEA (Root Mean Square Error of Approximation).

APPENDIX L:
Changes for Calibration of MCK/MPCK Primary Items

Exhibit L.1: Primary items

Item	Action	Comment
101	Drop 101B and 101D	101B directly contradicts 101A. 101D cannot be true; otherwise A, B, and C would be unanswerable.
102 103	Drop 102C Retain 103A	Redundancy but no dependency. 102C has poorest fit (MNSQ = 1.18).
	Combine 103B and 103B2 to one item	Some dependency between 103A and 103B.
		Score 2 if B1 and B2 correct; 1 if one correct, 0 if neither correct.
107	No change	No dependencies among items. Each had good fit (1.01 < MNSQ < 1.09).
202	No change	No dependencies among items. Each had good fit (0.84 < MNSQ < 1.13).
205A	Deleted	
209B	Deleted	
301	Deleted B1,B2	
302	Deleted A1, A4	
305B	Deleted	
306B	Deleted	
308	Recoded	Recoding response **1** as **0** and response **2** as **1**.
311	No change	No dependencies among items. Each had good fit (0.87 < MNSQ < 1.07).
403	Convert to one item	Serious dependencies—should have been a single MC item. All three correct, score 2, any correct score 1, otherwise 0.
411	Deleted	
413	Deleted 413B	
510	Convert to three items:	
	A1A2, A3A4, A5A6	Serious dependencies in each pair. Score each new item 1 if both correct, otherwise 0.

APPENDIX M:
Changes for Calibration of MCK/MPCK Secondary Items

Exhibit M.1: Secondary items

Item	Action	Comment
601	No change	No dependencies, satisfactory fit (0.5 < MNSQ < 1.11).
603C	Deleted	
609F	Deleted	
609	Convert to two items: Delete C and F Combine A and E Combine B and D.	All items are dependent on knowledge that .999... = 1. Score each newly constructed item 1 if all correct, otherwise 0
610B	Deleted	
613	Drop C	Some dependency in that answering A correctly makes C obvious. No fit problems.
614	Drop 614A	Dependency because 614A and 614B contradict each other. Only one can be true.
713	No change	No dependencies; adequate fit (0.94 < MNSQ < 101).
808	Convert to three items: A1A2, A3A4, A5A6	Serious dependencies in each pair. Score each new item 1 if both correct, otherwise 0
809D	Deleted	
812	812B4 rescaled	812B2 has already been deleted. 812B4 has already been recoded. Both of the responses **1** and **2** in the raw file are coded as correct response and scored as **1**. Response **3** is coded as incorrect response and scored as **0**.

APPENDIX N: Control Parameters for Model and Case Estimation: Mathematical Content Knowledge and Mathematics Pedagogical Content Knowledge

CALIBRATION

```
codes 0,1,2,3,4,5,7,9;
set update=yes,warnings=no, iterlimit=200, constraint=cases;
caseweight eqweight;
model item + item*step;
estimate ! method=quadrature,iter=15000,
        nodes=100,conv=0.00001,stderr=quick,fit=yes;
export parameters >> Item parameters.dat;
```

Note: Code 6 (Not reached) is counted as missing

ESTIMATION

```
codes 0,1,2,3,4,5,6,7,9;
set update=yes,warnings=no, iterlimit=200, constraint=cases;
import anchor_parameters Item parameters.dat;
model item + item*step;
estimate ! method=quadrature,iter=15000,
        nodes=100,conv=0.00001,stderr=quick,fit=yes;
show cases ! estimates=mle >>  Case Estimates.dat;
```

Note: Code 6 (Not reached) is counted as incorrect

APPENDIX O:
Mathematics Content Knowledge and Mathematics Pedagogical Content Knowledge Scales

Exhibit O.1

Scale	Variable Name	Dichotomously-Scored Items	Partial Credit Items
Mathematics Content Knowledge (Primary)	MCK	MFC101A MFC101C MFC102A MFC102B MFC103A MFC104 MFC106 MFC109 MFC110 MFC111 MFC201A MFC202A MFC202B MFC202C MFC202D MFC203 MFC204 MFC205B MFC205C MFC206A MFC207 MFC209A MFC209C MFC211 MFC301A MFC301C MFC302A2 MFC302A3 MFC303 MFC304 MFC305A MFC305C MFC306A MFC306C MFC307A MFC308 MFC309A MFC309B MFC309C MFC309D MFC310 MFC401 MFC402A MFC402B MFC402C MFC402D MFC404A MFC404B MFC404C MFC404D MFC407A MFC407B MFC408 MFC412A MFC412B MFC413A MFC501 MFC502A MFC503A MFC503B MFC503C MFC503D MFC504 MFC507A MFC507B MFC507C MFC508 MFC510A MFC510B MFC510C	MFC509 MFC511 MFC103B12 MFC403ABC
Mathematics Pedagogical Content Knowledge (Primary)	MPCK	MFC107A MFC107B MFC107C MFC107D MFC108 MFC206B MFC210 MFC311A MFC311B MFC311C MFC311D MFC312 MFC405A MFC405B MFC406A MFC406B MFC406C MFC406D MFC413B MFC506 MFC512	MFC105A MFC105B MFC201B MFC208A MFC208B MFC302B MFC307B MFC409 MFC410 MFC502B MFC505 MFC513
Mathematics Content Knowledge (Secondary)	MCK	MFC601A MFC601B MFC601C MFC601D MFC602 MFC604A1 MFC604A2 MFC606 MFC607 MFC608 MFC609A MFC609B MFC610A MFC610C MFC610D MFC612 MFC613A MFC613B MFC613D MFC614B MFC614C MFC615 MFC701B MFC705A MFC705B MFC706A MFC706B MFC706C MFC706D MFC707A MFC707B MFC707C MFC708A MFC708B MFC708C MFC708D MFC710A MFC710B MFC710C MFC713A MFC713B MFC713C MFC713D MFC801A MFC801B MFC801C MFC801D MFC801E MFC802A MFC802B MFC802C MFC802D MFC803A MFC803B MFC803C MFC803D MFC804 MFC806A MFC809A MFC809B MFC809C MFC811B MFC813 MFC609BD MFC609A MFC808A MFC808B MFC808C	MFC605A MFC605B MFC703 MFC704 MFC711 MFC714 MFC805 MFC807 MFC812A MFC814
Mathematics Pedagogical Content Knowledge (Secondary)	MPCK	MFC603A MFC603B MFC603D MFC604B MFC611A MFC611B MFC611C MFC611D MFC701A1 MFC701A2 MFC701A3 MFC701A4 MFC702 MFC709A MFC709B MFC709C MFC712A MFC712B MFC712C MFC712D MFC715 MFC806B MFC810 MFC811A MFC812B1 MFC812B3 MFC812B4	

APPENDIX P:
TEDS-M Test Reliabilities

Exhibit P.1

Primary MCK				
Sample	*Mean*	*Standard deviation*	*Reliability*	*Standard error of measurement*
International	**0.078**	**1.156**	**0.83**	**0.482**
Primary MPCK				
Sample	*Mean*	*Standard deviation*	*Reliability*	*Standard error of measurement*
International	**-0.060**	**1.024**	**0.66**	**0.594**
Secondary MCK				
Sample	*Mean*	*Standard deviation*	*Reliability*	*Standard error of measurement*
International	**0.120**	**1.110**	**0.91**	**0.331**
Secondary MPCK				
Sample	*Mean*	*Standard deviation*	*Reliability*	*Standard error of measurement*
International	**0.087**	**1.223**	**0.72**	**0.644**

APPENDIX Q:

Anchor Point Descriptions

Anchor Point 1

Future teachers of primary school mathematics at Anchor Point 1 are successful at performing basic computations with whole numbers, understand properties of operations with whole numbers, and are able to reason about related concepts such as odd or even numbers. They are able to solve some problems with fractions. Future teachers at this anchor point are successful at visualizing and interpreting two-dimensional and three-dimensional geometric figures, and can solve simple problems about perimeter. They can also understand straightforward uses of variables and the concept of equivalence, and can solve problems involving simple expressions and equations.

Future teachers at Anchor Point 1 are able to apply whole number arithmetic in simple problem-solving situations; however, they tend to over-generalize and have difficulty solving abstract problems and those requiring multiple steps. They have limited understanding of the concept of least common multiple, the number line, and the density of the real numbers. Their knowledge of proportionality and multiplicative reasoning is weak. They have difficulty solving problems that involve coordinates and problems about relations between geometric figures. Future teachers at this anchor point can make simple deductions, but they have difficulty reasoning about multiple statements and relationships among several mathematical concepts.

Anchor Point 2

Future teachers at Anchor Point 2 are successful at the mathematical tasks at Anchor Point 1. In addition, future teachers at Anchor Point 2 are more successful than future teachers at Anchor Point 1 at using fractions to solve story problems, and they can recognize examples of rational and irrational numbers. They know how to find the least common multiple of two numbers in a familiar context, and can recognize that some arguments about whole numbers are logically weak. They are able to determine areas and perimeters of simple figures, and have some notion of class inclusion among polygons. Future teachers at Anchor Point 2 also have some familiarity with linear expressions and functions.

However, while future primary teachers at Anchor Point 2 can solve some problems involving proportional reasoning, they have trouble reasoning about factors, multiples, and percentages. They are unable to solve problems about area of obtuse-angled triangles involving coordinate geometry. They do not recognize applications of quadratic or exponential functions, and have limited skills in algebraic reasoning.

Overall, future teachers at Anchor Point 2 do well on items testing “knowing,” and on standard problems about numbers, geometry, and algebra classified as “applying,” but they are not able to answer problems that require more complex reasoning in applied or nonroutine situations.

Examples

The examples below refer to the TEDS-M released items. For more detail on these items and for a complete listing of the TEDS-M released items, consult the *User Guide for the TEDS-M International Database* (Brese & Tatto, 2012).

Anchor Point 1

Following are examples of items that future primary teachers at Anchor Point 1 answered successfully at least 70 percent of the time.

- Reason about fractions to interpret simple numerical statements relating to a word problem.
- Identify the least likely outcome for a simple random experiment involving fractions with different denominators.
- Determine whether subtraction and division are commutative and addition is associative. (See released items MFC202A, MFC202B, and MFC202C)
- Interpret a diagram of a pan balance to determine the mass of an unknown quantity. (See released item MFC303)
- Determine whether the results of particular operations with even or odd numbers are odd or even. Recognize a net for a triangular-based prism. (See released item MFC501)
- Interpret a bar chart and some verbal clues to solve a problem about the number of items sold. (See released item MFC502A)
- Identify common rational numbers. (See released item MFC503B)

Following are examples of items that future primary teachers at Anchor Point 1 answered successfully less than 50 percent of the time.

- Determine whether subtraction of whole numbers is associative. (See released item MFC202D)
- Identify the correct Venn diagram to illustrate the relation between four types of quadrilateral. (See released item MFC204)
- Understand that there are an infinite number of decimal numbers between two given numbers. (See released item MFC304)
- Find a linear algebraic rule to describe a general situation illustrated by a diagram. (See released item MFC308)
- Find the area of a triangle drawn on a grid. (See released item MFC408)
- Identify an algebraic representation of a numerical relationship between three consecutive even numbers.

Anchor Point 2

The following are examples of items that future primary teachers at Anchor Point 2 answered successfully at least 70 percent of the time.

- Identify the truth of a statement about the solvability of a word problem involving proportional reasoning.
- Determine whether subtraction of whole numbers is associative. (See released item MFC202D)

- Determine the area of a walkway around a rectangular pool. (See released item MFC203)
- Interpret Venn diagrams representing relationships between quadrilaterals. (See released item 204)
- Identify the solution to a word problem involving a rate and requiring some proportional reasoning. (See released item 206A)
- Recognize whether some story problems correctly model the subtraction of two fractions.
- Identify the difference between the perimeter and area of a rectangle drawn on dot paper.
- Indicate whether π and $\sqrt{49}$ are rational or irrational. (See released items MFC503A and MFC503C)
- Identify a future term in a linear rule represented visually. (See released item MFC508)

The following are examples of items that future teachers at Anchor Point 2 answered successfully less than 50 percent of the time.

- Use proportional reasoning to interpret numerical statements involving percentage relating to a word problem.
- Identify the true probability statement relating to a game involving two dice. (See released item MFC106)
- Write a correct statement about the reflection image of the point with coordinates (a, b) over the x-axis.
- Identify a set of geometric statements that uniquely define a square.
- Describe properties of the function defined by the ratio of the area and circumference of a circle
- Identify whether $-\frac{3}{2}$ is rational or irrational. (See released item MFC503D)
- Determine the conditions for which one linear algebraic expression is greater than or equal to another. (See released item MFC509)
- Compare lengths on a cube and a cylinder with common dimensions. (See released item MFC513)

Anchor Point Descriptions for the MPCK of Future Teachers Who Took the Primary Test

Note: There was only one anchor point for the MPCK test.

Future primary teachers at this anchor point are able to recognize the correctness of a teaching strategy for a particular concrete example, and are able to evaluate students' work when the mathematics content is conventional or typical of primary grades. They are able to identify the arithmetic elements of single-step story problems that influence their difficulty (see released item MFC505).

While future primary teachers at the primary MPCK anchor point have some ability to interpret student solution methods, identify the skills inherent in a task, and identify student difficulties, they may not be able to articulate them as clearly and concisely as more able future teachers (see released item MFC502B). Similarly, future teachers at this anchor point can partially identify and compare the attributes of the graphical representations of young children but not as well as their more able counterparts (see released item MFC410).[2]

However future teachers at this anchor point may not know how to use concrete representations to support students' learning (see released item MFC312), and may not recognize how a student's thinking is related to a particular algebraic representation (see released item MFC108). They may not sufficiently understand some measurement or probability concepts in order to reword or design a task (see released item MFC307B).

Future teachers at this anchor point may not know why a particular teaching strategy would make sense (see released item MFC513), whether a strategy can be generalized to a larger class of problems, or if it will always work. They may be unaware of common misconceptions and unable to conceive useful representations of numerical concepts (see released items MFC208A & MFC208B).

Anchor Point Descriptions for the MCK of Future Teachers Who Took the Lower-Secondary Test

Anchor Point 1

Future teachers of lower-secondary school mathematics who perform at Anchor Point 1 know concepts related to whole numbers, integers, and rational numbers and can do computations with them. They also can evaluate algebraic expressions and solve simple linear and quadratic equations, particularly those that are solvable by substitution or trial and error. They are familiar with standard geometric figures in the plane and space, and can identify and apply simple relations in plane geometry. They are also able to interpret and solve more complex problems in number, algebra, and geometry if the context or the problem type is a commonly taught topic in lower-secondary schools.

However, future teachers at Anchor Point 1 have difficulty describing general patterns, solving multistep problems if these have complex linguistic or mathematical relations, and relating equivalent representations of concepts. They tend to over-generalize concepts and do not have a good grasp of mathematical reasoning. In particular, they do not consistently recognize faulty arguments or are able to justify or prove conclusions.

Anchor Point 2

Future teachers who perform at Anchor Point 2 successfully answer all the mathematics problems in Anchor Point 1. In addition, they seem to have a more robust notion of function, especially of linear, quadratic, and exponential functions, are better able to read, analyze, and apply abstract definitions and notation, and have greater ability than a future lower-secondary teacher at Anchor Point 1 to make and recognize simple arguments. They also know some definitions and theorems from university-level courses such as calculus, abstract algebra, and college geometry, and can apply them in straightforward situations.

However, future teachers at Anchor Point 2 are rarely consistently successful in solving problems stated in purely abstract terms, or with problems containing foundational material such as axiomatic systems in geometry. Additionally, they make errors in

2 MFC410 and MFC502B are examples of where future teachers at the anchor point have been awarded partial credit for their responses, thereby indicating some proficiency.

logical reasoning, such as not attending to all conditions of definitions or theorems and confusing the truth of a statement with the validity of an argument. They are also unable to recognize valid proofs of more complex statements. Even though they may be able to make some progress in constructing a mathematical proof, future teachers performing at Anchor Point 2 are not generally successful at completing mathematical proofs.

Examples

The examples below refer to the TEDS-M released items. For more detail on these items and for a complete listing of the TEDS-M released items, consult the *User Guide for the TEDS-M International Database* (Brese & Tatto, 2012).

Anchor Point 1

The following are examples of items that future lower-secondary teachers at Anchor Point 1 answered successfully at least 70 percent of the time.

- Solve a simple linear or quadratic equation and identify the smallest set of numbers to which the solution belongs.
- Solve word problems involving ratios of whole numbers (see released item MFC604A1) or sums of consecutive integers.
- Determine if angles in a triangle are congruent using given information.
- Determine the number of lines of symmetry in a regular polygon. (See released items MFC808A1, MFC808A2, MFC808B1, and MFC808B2)
- Determine whether a given translation or reflection maps one figure to another.

The following are examples of items that future lower-secondary teachers at Anchor Point 1 answered successfully less than 50 percent of the time.

- Solve a word problem with a more complex linguistic or logical structure or one in which the choice of variable is not obvious. (See released item MFC604A2)
- Generalize patterns involving linear and nonlinear growth.
- Determine whether a given composite of transformations maps one figure to another.
- Solve equations in one variable and describe the solution set in the coordinate plane or space. (See released items MFC705A and MFC705B)
- Write a proof of a statement about the sum of two functions. (See released item MFC711)
- Identify an appropriate definition for a function that is continuous at a point.
- Identify the consequences of replacing a particular axiom in geometry.

Anchor Point 2

The following are examples of items that future lower-secondary teachers at Anchor Point 2 answered successfully at least 70 percent of the time.

- Solve problems about properties of angles or triangles.
- Determine if the relation "is similar to" satisfies the reflexive, symmetric, and transitive properties.

- Identify a situation that is modeled by an exponential function. (See released items MFC710A, B, and C)
- Identify the consequences of replacing a particular axiom in geometry.
- Make some progress toward solving a problem about conditional probability.
- Write part of a proof related to the sum of two functions. (See released item MFC711)
- Recognize that a particular algebraic argument about the divisibility of a square of any natural number is a valid proof. (See released item MFC802B)

The following are examples of items that future lower-secondary teachers at Anchor Point 2 answered successfully less than 50 percent of the time.

- Determine properties of absolute value.
- Find solutions to equations in the set of complex numbers or integers modulo 6.
- Interpret standard deviation when distributions are presented visually.
- Determine whether statements about abstract concepts are equivalent.
- Work with foundational materials such as axiomatic systems in geometry.
- Write a complete proof about the sum of two functions. (See released item MFC711)
- Solve problems about combinations. (See released item MFC804)

Anchor Point Descriptions for the MPCK of Future Teachers Who Took the Lower-Secondary Test

Note: There was only one anchor point for the MPCK test.

Future lower-secondary teachers who are at the anchor point on the MPCK scale have a variable range of knowledge of the lower-secondary curriculum and of planning for instruction. For instance, they know prerequisite knowledge and steps for teaching a derivation of the quadratic formula (see released items MFC712A, B, C, and D) and can determine the consequences of moving the concept of square root from the lower-secondary to the upper-secondary school mathematics curriculum. However, they have difficulty deciding what would be a helpful mathematics concept to use in a proof about isosceles triangles.

Future teachers at this anchor point also have some skill in enacting school mathematics. They can sometimes correctly evaluate students' mathematical work. For example, they can determine whether a student's diagram satisfies certain given conditions in geometry, and they can recognize a student's correct prose argument about divisibility of whole numbers (see released item MFC709A).

However, they cannot identify the correct solution to a trigonometry problem, and cannot consistently apply a rubric with descriptions of three performance levels to evaluate students' solutions to a problem about linear and nonlinear growth.

Future teachers at this anchor point are successful at analyzing students' errors when the students' work involves single-step or short explanations, but they are less successful at identifying or analyzing errors in more complex mathematical situations. For instance, future teachers at this level can identify an error in misreading a histogram (see released item MFC806B), but cannot explain why one word problem is more difficult for students than another (see released item MFC604B).

In general, future teachers' own depth of mathematical understanding seems to influence their ability to interpret students' thinking or to determine appropriate responses to students. Because future teachers at this level lack a well-developed concept of the meaning of a valid mathematical argument, they have difficulty evaluating some invalid arguments. In particular, they do not recognize that examples are not sufficient to constitute a proof (see released item MFC709B). They also are not able to recognize whether certain word problems correctly exemplify expressions involving the division of fractions.

Reference

Brese, F., & Tatto, M. T. (Eds.). (2012). *User guide for the TEDS-M international database.* Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

APPENDIX R:
Program-Groupings: Future Teachers (Primary)

Exhibit R.1

Program-Group	Country	Programs	Number of Respondents	Grade Span	
				Low	*High*
Program-Type 1. Lower Primary Generalists (to Grade 4 Maximum)	Georgia	Bachelor in Pedagogy (five years)	21	1	4
		Bachelor in Pedagogy (four years)	485		
	Germany	Primary with mathematics as a focus (Type 1A)	360	1	4
		Primary without mathematics as a focus (Type1B)	162	1	4
		Primary and Secondary generalist (Type 2B)	413	1	4
	Poland *	B. Pedagogy, integrated teaching (first cycle, fulltime)	510	1	3
		B. Pedagogy, integrated teaching (long cycle, fulltime)	268	1	3
		B. Pedagogy, integrated teaching (first cycle, parttime)	828	1	3
		B. Pedagogy, integrated teaching (long cycle, parttime)	206	1	3
		B. Pedagogy, integrated teaching (second cycle, fulltime)	72	1	3
		B. Pedagogy, integrated teaching (second cycle, parttime)	293	1	3
	Russian Federation	Primary teacher education	2,266	1	4
	Switzerland	Teacher for kindergarten and primary to Grade 2	75	K	2
		Teacher for kindergarten and primary to Grade 3	46	K	3
Program-Type 2. Primary Generalists (to Grade 6 Maximum)	Chinese Taipei	Elementary teacher education	923	1	6
	Philippines	Bachelor in Elementary Education	592	1	6
	Singapore	Bachelor of Arts in Education (Primary), four years	31	1	6
		Bachelor of Science in Education (Primary), four years	36	1	6
		Diploma of Education (Primary), Option C, two years (consecutive)	107	1	6
		Post-Graduate Diploma in Education (Primary), Option C, one year (consecutive)	89	1	6
	Spain	Teacher of primary education	1,093	1	6
	United States	Teacher for primary school Grades 1 to 6	556	1	6
		Teacher for primary school, Grades 3 to 6	24	3	6
		Teacher for kindergarten and primary school, Grade 6	235	K	6
		Primary teacher education (concurrent)	1,137	1	4–5

Exhibit R.1 (contd.)

Program-Group	Country	Programs	Number of Respondents	Grade Span	
				Low	*High*
Program-Type 3. Primary/Lower-Secondary Generalists (to Grade 4 Maximum	Botswana	Diploma in Primary Education	86	1	7
	Chile	Generalist teachers (Grades 1 to 8)	657	1	8
	Norway **	ALU–general teachers for primary and lower secondary (plus mathematics)	159	1	10
		ALU–general teachers for primary and lower secondary	392	1	10
Program-Type 4. Primary Mathematics Specialists	Germany	Primary and secondary—mathematics as a focus	97	1	10
	Malaysia	Bachelor of Education (Primary)	17	1	6
		Diploma of Education (Mathematics)	47	1	6
		Malaysian Teaching Diploma (Mathematics)	512	1	6
	Poland *	Mathematics (first cycle, fulltime, teacher education)_1	134	4	9
		Mathematics (long cycle, fulltime, teacher education)_3	123	4	12
		Mathematics (first cycle, parttime, teacher education)_4	20	4	9
		Mathematics (long cycle, parttime, teacher education)_6	23	4	12
	Singapore	Diploma of Education, Primary Option A, two years	45	1	6
		Post-Graduate Diploma of Education (Primary), Option A, one year	72	1	6
	Thailand	Bachelor of Education (five years)	599	1	12
		Graduate Diploma in the Teaching Profession	61	1	12
	United States	Primary and secondary teacher education (concurrent)	184	4	9
		Primary and secondary teacher education (consecutive)	7	4	9

Notes:

* Poland data include second-cycle programs that did not meet IEA sampling requirements and are therefore reported separately.

** Norway data include ALU programs that did not meet IEA sampling requirements and are therefore reported separately.

APPENDIX S:
Program-Groupings: Future Teachers (Secondary)

Exhibit S.1

Program-Group	Country	Programs	Number of Respondents	Grade Span
Program-Type 5: Lower-Secondary Mathematics (to Grade 10 Maximum)	Botswana	Diploma in Secondary Education	34	8–10
	Chile	Generalists teachers (Grades 1 to 8)	648	1–8
		Generalist teachers + mathematics (Grades 5 to 8)	98	5–8
	Germany	Primary and secondary generalist (Type 2A)	87	1–10
		Secondary I with mathematics as a focus (Type 3)	321	5–10
	Norway *	ALU	356	1–10
		ALU (plus mathematics)	151	1–10
	Philippines	Bachelor in Secondary Education	733	7–10
	Poland	Mathematics (first cycle, fulltime, teacher education)_1	135	4–9
		Mathematics (first cycle, parttime, teacher education)_4	23	4–9
	Singapore	Post-Graduate Diploma in Education (Lower-Secondary), one year, January 2007 intake	50	7–8
		Post-Graduate Diploma in Education (Lower-Secondary), one year, July 2007 intake	92	7–8
	Switzerland	Teacher for secondary school	141	7–9
	United States	Primary and secondary teacher (concurrent)	161	4/5–8/9
		Primary and secondary teacher (consecutive)	8	4/5–89

Exhibit S.1 (contd.)

Program-Group	Country	Programs	Number of Respondents	Grade Span
Program-Type 6. Lower-Secondary Mathematics (to Grade 11 and above)	Botswana	Bachelor of Education	19	8–12
	Chinese Taipei	Secondary mathematics teacher education	365	7–12
	Georgia	Bachelor in Mathematics	69	1–12
		Master in Mathematics	9	5–12
	Germany	Secondary II with mathematics as a focus (Type4)	363	5–13
	Malaysia	Bachelor of Arts in Education (Mathematics), Secondary	43	7–13
		Bachelor of Science in Education (Mathematics), Secondary	346	7–13
	Norway *	PPU	43	8–13
		Master's degree	22	8–13
	Oman	Bachelor of Education, four years, university	30	5–12
		Bachelor of Education, four years, colleges of education	222	5–12
		Educational Diploma (after completing Bachelor of Science), six years	16	5–12
	Poland **	Mathematics (long cycle, fulltime, teacher education)_3	122	4–12
		Mathematics (long cycle, parttime, teacher education)_6	18	4–12
		Mathematics (second cycle, fulltime, teacher education)_2	30	4–12
		Mathematics (second cycle, parttime, teacher education)_5	59	4–12
	Russian Federation	Teacher of mathematics	2,141	5–11
	Singapore	Post-Graduate Diploma in Education (Secondary), one year, January 2007 intake	105	7–12
		Post-Graduate Diploma in Education (Secondary), one year, July 2007 intake	146	7–12
	Thailand	Bachelor of Education, five years	596	1–12
		Graduate Diploma in Teaching Profession	56	1–12
	United States	Secondary teacher (concurrent)	356	6/7–12
		Secondary teacher (consecutive)	82	6/7–12

Notes:

* Norway data include ALU and Master's programs that did not meet IEA sampling requirements and are therefore reported separately.

** Poland data include second-cycle programs that did not meet IEA sampling requirements and are therefore reported separately.

APPENDIX T:

Listings of Organizations and Individuals Responsible for TEDS-M

TEDS-M Joint Management Committee

- MSU: Maria Teresa Tatto (chair), Sharon Senk, John Schwille
- ACER: Lawrence Ingvarson, Ray Peck, Glenn Rowley
- IEA: Hans Wagemaker, Barbara Malak (*ex-officio*)
- DPC: Dirk Hastedt (*ex-officio*), Ralph Carstens (*ex-officio*), Falk Brese (*ex-officio*), and Sabine Meinck (*ex-officio*)
- Statistics Canada: Jean Dumais (*ex-officio*)

The International Study Center at Michigan State University (TEDS-M Lead Institution)

- Maria Teresa Tatto, TEDS-M executive director and principal investigator
- Sharon L. Senk and John Schwille, co-directors and co-principal investigators
- Kiril Bankov, University of Sofia, senior research coordinator for mathematics and mathematics pedagogy knowledge
- Michael Rodriguez, University of Minnesota, senior research coordinator for statistics, measurement, and psychometrics
- Martin Carnoy, Stanford University, senior research coordinator for the cost study
- Yukiko Maeda, research associate for statistics, measurement, and psychometrics
- Soo-Yong Byun, research associate for statistics and data analysis
- Mustafa Demir, Todd Drummond, Richard Holdgreve-Resendez, Nils Kauffman, Wangjun Kim, Patrick Leahy, Yang Lu, Sungworn Ngudgratoke, Irini Papaieronymou, Eduardo Rodrigues, and Tian Song, research assistants
- Inese Berzina-Pitcher, consortium coordinator
- Ann Pitchford, administrative assistant

The Australian Council for Educational Research (ACER)

- Lawrence Ingvarson, co-director
- Ray Peck, co-director, primary mathematics
- Glenn Rowley, co-director, statistics and measurement

Todd Drummond, Patrick Leahy, and Richard Holdgreve-Resendez are also acknowledged for their assistance during the TEDS-M project.

International Association for the Evaluation of Educational Achievement (IEA)

- Hans Wagemaker, executive director
- Barbara Malak, manager membership relations
- Juriaan Hartenberg, financial manager

IEA Data Processing and Research Center (IEA DPC)

- Dirk Hastedt, co-director
- Falk Brese, project coordinator
- Ralph Carstens, project coordinator
- Sabine Meinck, sampling methodologist/coordinator

TEDS-M International Sampling Referee

- Jean Dumais, Statistics Canada

TEDS-M International Sampling Adjudicator

- Marc Joncas, Statistics Canada

TEDS-M National Research Coordinators (NRCs)

Country	Name	Affiliation
Botswana	Thabo Jeff Mzwinila Tuelo Martin Keitumetse	Tlokweng College of Education
Canada	Pierre Brochu	Council of Ministers of Education, Canada, Pan-Canadian Assessment Program
Chile	Beatrice Avalos	Ministry of Education, Chile, Unit of Curriculum Evaluation
Chinese Taipei	Feng-Jui Hsieh Pi-Jen Lin	National Taiwan Normal University, Department of Mathematics National Hsinchu University of Education, Department of Applied Mathematics
Georgia	Maia Miminoshvili Tamar Bokuchava	National Assessment and Examination Center
Germany	Sigrid Blömeke	Humboldt University of Berlin, Faculty of Arts IV
Malaysia	Mohd Mustamam Abd. Karim Rajendran Nagappan	Universiti Pendidikan Sultan Idris
Norway	Liv Grønmo	University of Oslo, Department of Teacher Education and School Development
Oman	Zuwaina Al-maskari	Ministry of Education, Math Curriculum Department
Philippines	Ester Ogena Evangeline Golla	Science Education Institute, Department of Science and Technology
Poland	Michał Sitek	Polish Academy of Sciences, Institute of Philosophy and Sociology
Russian Federation	Galina Kovaleva	Russian Academy of Education, Center for Evaluating the Quality of Education, Institute for Content of Methods of Learning,
Singapore	Khoon Yoong Wong	Nanyang Technological University, National Institute of Education
Spain	Luis Rico Pedro Gomez	University of Granada
Switzerland	Fritz Oser Horst Biedermann	University of Fribourg
Thailand	Precharn Dechsri Supattra Pativisan	The Institute for the Promotion of Teaching Science and Technology
United States	William Schmidt	Michigan State University

TEDS-M Expert Panels and Meetings

Specialist Advisory/Expert Panel Meetings for TEDS-M, November 2002

Meeting	Participants	Country/Affiliation
Special IEA advisory meeting on approval of TEDS-M Study, Brussels, Belgium November 4–5, 2002	Fernand Rochette	
	Belgium (Flemish)	
	Liselotte Van De Perre	Belgium (Flemish)
	Ann Van Driessche	Belgium (Flemish)
	Marcel Crahay	Belgium (French)
	Julien Nicaise	Belgium (French)
	Per Fibæk Laursen	Denmark
	Bjarne Wahlgren	Denmark
	Gerard Bonnet	France
	Catharine Regneir	France
	Ranier Lehmann	Germany
	Georgia K. Polydores	Greece
	Bruno Losito	Italy
	Ryo Watanabe	Japan
	Andris Kangro	Latvia
	Jean-Claude Fandel	Luxembourg
	Jean-Paul Reeff	Luxembourg
	Seamus Hegarty	UK
	Arlette Delhaxe	Eurydice
	Barbara Malak-Minkiewicz	IEA Secretariat
	Maria Teresa Tatto	MSU

Specialist Advisory/Expert Panel Meetings for TEDS-M, June 2003

Meeting	Participants	Country/Affiliation
IEA TEDS-M expert panel meeting, Amsterdam, The Netherlands, June 16–21, 2003	Peter Fensham	Australia
	Kiril Bankov	Bulgaria
	Martial Dembele	Burkina Faso and Québec-Canada
	Beatrice Avalos	Chile
	Per Fibæk Laursen	Denmark
	Sigrid Blömeke	Germany
	Frederick Leung	Hong Kong SAR
	Losito Bruno	Italy
	Ciaran Sugrue	Ireland
	Lee Chong-Jae	Korea
	Loyiso Jita	South Africa
	Marilyn Leask	UK
	Christopher Day	UK
	Michael Eraut	UK
	Drew Gitomer	USA
	Susanna Loeb	USA
	Lynn Paine	USA
	David Plank	USA
	Paul Sally	USA
	William Schmidt	USA
	Adrian Beavis	IEA-TEDS-M ACER
	Lawrence Ingvarson	IEA-TEDS-M ACER
	Jack Schwille	IEA-TEDS-M MSU
	Maria Teresa Tatto	IEA-TEDS-M MSU

Specialist Advisory/Expert Panel Meeting for TEDS-M, December 2003

Meeting	Participants	Country/Affiliation
IEA TEDS expert panel meeting, Hamburg, Germany, December 1–5, 2003	Peter Fensham	Australia
	Kiril Bankov	Bulgaria
	Beatrice Avalos	Chile
	Per Fibæ Laursen	Denmark
	Sigrid Blömeke	Germany
	Frederick Leung	Hong Kong
	Ciaran Sugrue	Ireland
	Bruno Losito	Italy
	Tenoch Cedillo Avalos	Mexico
	Marcela Santillan-Nieto	Mexico
	Loyiso C. Jita	South Africa
	Marilyn Leask	UK
	Angelo Collins	USA
	Lynn Paine	USA
	Hans Wagemaker	IEA
	Pierre Foy	IEA DPC
	Dirk Hastedt	IEA DPC
	Lawrence Ingvarson	IEA-TEDS-M ACER
	Jack Schwille	IEA-TEDS-M MSU
	Maria Teresa Tatto	IEA-TEDS-M MSU

Specialist Advisory/Expert Panel Meetings for TEDS-M, June 2006

Meeting	Participants	University
Expert panel for review of TEDS-M items and data from field trial East Lansing, Michigan, USA June, 2006	Edward Aboufadel	Grand Valley State University
	Sandra Crespo	MSU
	Glenda Lappan	MSU
	Vince Melfi	MSU
	Jeanne Wald	MSU
	Rebecca Walker	Grand Valley State University

Specialist Advisory/Expert Panel Meetings for TEDS-M, September 2006

Meeting	Participants	University
Expert panel for review of primary TEDS-M items for mathematics content knowledge and mathematics pedagogy content knowledge, Melbourne, Australia September 18, 2006	Doug Clarke	Australian Catholic University
	Peter Sullivan	Monash University
	Kaye Stacey	Melbourne University
	Gaye Williams	Deakin University
	Barb Clarke	Monash University
	Ann Roche	Australian Catholic University
	Ray Peck	IEA TEDS-M ACER
	Lawrence Ingvarson	IEA TEDS-M ACER

Specialist Advisory/Expert Panel Meetings for TEDS-M, September 2006

Meeting	Participants	Country/Affiliation
Expert panel for review of TEDS-M test items and questionnaires, Grand Rapids, Michigan, USA September 29–30, 2006	Kiril Bankov	Bulgaria
	Jarmila Novotna	Czech Republic
	Paul Conway	Ireland
	Ruhama Even	Israel
	Kyungmee Park	Korea
	Maarten Dolk	Netherlands
	Ingrid Munck	Sweden
	Hyacinth Evans	West Indies
	Lynn Paine	IEA-TEDS-M MSU
	Sharon Senk	IEA-TEDS-M MSU
	Jack Schwille	IEA-TEDS-M MSU
	Maria Teresa Tatto	IEA-TEDS-M MSU

Specialist Advisory/Expert Panel Meetings for TEDS-M, June and July 2009

Meeting	Participants	University
TEDS-M Mathematics and Mathematics Pedagogy Scale Anchoring Workshops in East Lansing, MI. Note: The objective of these workshops was to develop descriptions of the characteristics of persons whose scores on the mathematics and mathematics pedagogy tests placed them at various locations on the scales.	*Mathematicians Primary*	
	Anna Bargagliotti	University of Memphis
	Hyman Bass	MSU
	Michael Frazier	University of Tennessee
	Mathematicians Lower Secondary	
	Roger Howe	Yale University
	Cathy Kessel	Independent consultant
	Alejandro Uribe	University of Michigan
	Jeanne Wald	MSU
	Mathematics Educators—Primary	
	Lillie Albert	MSU
	Sandra Crespo	MSU
	Cynthia Langrall	Illinois State University
	Edward Silver	University of Michigan
	Alejandra Sorto	Texas State University
	Rebecca Walker	Grand Valley State University
	Mathematics Educators—Lower-Secondary	
	Jennifer Bay Williams	University of Louisville
	Jeremy Kilpatrick	University of Georgia
	Glenda Lappan	MSU
	Xuihui Li	California State University
	Sharon McCrone	University of New Hampshire
	Rheta Rubenstein	University of Michigan
	Denisse Thompson	University of South Florida

During the 55 years of its activities, IEA has conducted over 30 comparative research studies focusing on educational policies, practices, and outcomes in various school subjects in more than 80 countries around the world. The Teacher Education and Development Study in Mathematics (TEDS-M), the first IEA project addressing tertiary education, examined the mathematics preparation of future teachers for both primary and secondary school levels in 17 countries.

The study's key research questions focused on the relationships between teacher education policies, institutional practices, and the mathematics and pedagogy knowledge of future teachers at the end of their preservice education. Data were gathered from approximately 22,000 future teachers from 750 programs in about 500 teacher education institutions. Teaching staff within these programs were also surveyed. They included close to 5,000 mathematicians, mathematics educators, and general pedagogy educators.

TEDS-M collected data on policies, practices, and outcomes of mathematics teacher education. These data permitted comparisons of teacher education-related national policies, organization, and curricula across the participating countries. The data also elucidated the main characteristics of institutions preparing primary and lower-secondary teachers of mathematics. Analyses of the various national teacher education programs show the opportunities to learn that they offer and—in this context—future teachers' mathematics content knowledge and mathematics pedagogy knowledge, as well as their beliefs related to mathematics and the learning of mathematics.

Findings from TEDS-M were published in a series of reports presenting study outcomes. These reports are complemented by the international database (together with its user guide) and this latest technical report. It includes detailed information on instrument development, translation and verification procedures, sampling, field operations and quality control, data management, database construction, weighting procedures, scaling methodology, and the reporting of data from the surveys of future teachers of mathematics and their educators. The technical report enables fellow researchers in the field to evaluate the published reports, monographs, and articles based on TEDS-M data and to conduct their own secondary analyses.