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)

Maria Teresa Tatto
John Schwille
Sharon L. Senk
Lawrence Ingvarson
Glenn Rowley
Ray Peck
Kiril Bankov
Michael Rodriguez
Mark Reckase

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)

Maria Teresa Tatto
John Schwille
Sharon L. Senk
Lawrence Ingvarson
Glenn Rowley
Ray Peck
Kiril Bankov
Michael Rodriguez
Mark Reckase

with
Jean Dumais, Ralph Carstens, Falk Brese, Sabine Meinck,
Inese Berzina-Pitcher, Yang Lu, and Richard Holdgreve-Resendez

TEDS-M

ISBN/EAN: 978-90-79549-12-2

Copies of *Policy, Practice, and Readiness to Teach Primary and Secondary Mathematics in 17 Countries* can be obtained from:

IEA Secretariat
Herengracht 487
1017 BT Amsterdam, the Netherlands
Telephone: +31 20 625 3625
Fax: + 31 20 420 7136
Email: Department@IEA.nl
Website: www.iea.nl

Printed by Multicopy, Amsterdam, The Netherlands
Edited by Paula Wagemaker Editorial Services, Christchurch, New Zealand
Designed by Becky Bliss Design and Production, Wellington, New Zealand

Foreword

As an international non-profit research organization, the International Association for the Evaluation of Educational Achievement (IEA) has, over the past 50 years, conducted a large number of studies which focus on the outcomes of schooling in key subject-matter areas at important educational transition points. These studies have provided powerful insights into the home- and school-based factors implicated in learning outcomes at the school level. However, IEA has not focused undivided attention on what is arguably the key element of successful learning—teachers. The IEA Teacher Education and Development Study-Mathematics (TEDS-M) is a step toward remedying that situation.

TEDS-M represents the first large-scale, international comparative study of the preparation of primary and lower-secondary (specifically, mathematics) teachers. IEA considers TEDS-M a landmark study in terms of its examination, within both national and international contexts, of country-level policies relating to the preparation of future teachers of mathematics. The authors of this report look closely at how these policies are played out in the participating countries' varied teacher education programs and instructional practices, and speculate on the implications of these programs and practices for student learning in schools. They also suggest how TEDS-M might contribute to ongoing research into teacher education.

IEA sees TEDS-M as a blueprint for ongoing IEA (and other interested parties') work on teaching teachers to teach. The study evolved through a collaborative process involving many individuals and experts from around the world, including not only the study directors but also expert panel members and national research coordinators.

Support for this project was provided by generous funding from the US National Science Foundation, participating countries, and from IEA's own resources. It is, however, ultimately the responsibility of a number of key individuals to ensure that the ambitious goals of projects such as this one are translated into reality.

For their efforts in making TEDS-M and like projects a reality, I thank in particular Michigan State University's (MSU) Dr Maria Teresa Tatto, the study's executive director and a principal investigator. I also offer sincere thanks to the study's co-directors and investigators: Dr Jack Schwille and Dr Sharon Senk, from Michigan State University, and Dr Lawrence Ingvarson, Dr Glenn Rowley, and Dr Ray Peck from the Australian Council for Educational Research (ACER). MSU and ACER provided the international research centers for TEDS-M. Thanks go to the researchers from both centers who contributed to this project.

I furthermore acknowledge Dr Barbara Malak of the IEA Secretariat along with Dirk Hastedt, Ralph Carstens, Falk Brese, Sabine Meinck, and Robert Whitwell of the IEA Data Processing and Research Center for their contributions to the development and reporting of this project. Jean Dumais from Statistics Canada served the important role of sampling referee for TEDS-M.

IEA studies rely on national teams headed by the national research coordinators in participating countries. They are the people who manage and execute the study at the national level. Their contribution is highly appreciated. This study also would not be possible without the participation of many futures teachers, teacher educators, and policymakers within these countries. The education world benefits from their commitment.

Hans Wagemaker
Executive Director, IEA
AMSTERDAM, MARCH 2012

Table of Contents

LIST OF EXHIBITS

Appendices

CHAPTER 1:

THE TEACHER EDUCATION AND DEVELOPMENT STUDY IN MATHEMATICS: AN INTRODUCTORY OVERVIEW

1.1. TEDS-M—Genesis, Purpose, Participants, and Funding

The Teacher Education Study in Mathematics (TEDS-M) 2008 is the first cross-national study to provide data on the knowledge that future primary and lower-secondary school teachers acquire during their mathematics teacher education. It is also the first major study to examine variations in the nature and influence of teacher education programs within and across countries.

The impetus for TEDS-M, conducted in 17 countries under the aegis of the International Association for the Evaluation of Educational Achievement (IEA), was recognition that teaching mathematics in primary and secondary schools has become more challenging worldwide as knowledge demands change and large numbers of teachers reach retirement age. It has also become increasingly clear that effectively responding to demands for teacher preparation reform will remain difficult while there is lack of consensus on what such reform should encompass and while the range of alternatives continues to be poorly understood let alone based on evidence of what works. In the absence of empirical data, efforts to reform and improve educational provision in this highly contested arena continue to be undermined by tradition and implicit assumptions. TEDS-M accordingly focused on collecting, from the varied national and cultural settings represented by the participating countries, empirical data that could inform policy and practice related to recruiting and preparing a new generation of teachers capable of teaching increasingly demanding mathematics curricula.

Two particular purposes underpinned this work. The first was to identify how the countries participating in TEDS-M prepare teachers to teach mathematics in primary and lower-secondary schools. The second was to study variation in the nature and impact of teacher education programs on mathematics teaching and learning within and across the participating countries. The information collected came from representative samples (within the participating countries) of preservice teacher education programs, their future primary and lower-secondary school 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 knowledge.

The 17 countries that participated in TEDS-M 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), Thailand, and the United States of America (public institutions only).

Michigan State University (MSU) and the Australian Council of Educational Research (ACER) were selected as the international study centers for TEDS-M. The members of the two international centers and the national research coordinators (NRCs) of the participating countries worked together from 2006 to 2011 on the study, which received funding from the United States of America National Science Foundation, IEA, and the collaborating countries.

TEDS-M is sponsored by IEA. IEA generously contributed funds that helped initiate and sustain this innovative study. Each participating country was responsible for funding national project costs and implementing TEDS-M 2008 in accordance with the international procedures.

The international costs for TEDS-M 2008 were co-funded by the US National Science Foundation NSF REC 0514431 9/15/2005 to 2/5/2012. Principal investigator (PI): Maria Teresa Tatto. Co-PIs: John Schwille and Sharon Senk.

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.

1.2 Factors of Potential Relevance to the Education and Performance of Future Teachers

Justification for this study and the development of its conceptual framework, design, and methodology were grounded in and supported by the findings of a review of relevant research literature. The review highlighted five fundamental sources of variation within and across nations with respect to the teaching and learning of mathematics. These sources were also deemed to be those with the most potential relevance to the education and performance of future teachers. They are briefly described in the following sections.

1.2.1 Student Achievement in Mathematics

Data from IEA's Trends in International Mathematics and Science Study (TIMSS) 2007 showed considerable variation in the average national achievement scores of students from the 37 countries that participated in the study's Grade 4 mathematics test and the 48 countries that participated in the Grade 8 mathematics test.

At the Grade 4 level, scores on the international achievement scale ranged from 224 points in Yemen to 607 points in Hong Kong SAR (Mullis et al., 2008). Twenty countries had average scores at or above the TIMSS international scale average of 500. Students who attained the highest scores (ranging from 607 to 568) were those from Hong Kong SAR, Singapore, Chinese Taipei, and Japan. Students in the Russian Federation, England, the United States, and Germany had slightly lower average scale scores, ranging from 544 in the Russian Federation to 525 in Germany.

At the Grade 8 level, the gap was even wider: students in only 12 out of the 48 countries scored at or above the TIMSS scale average of 500. Students in five countries—Chinese Taipei, the Republic of Korea, Singapore, Hong Kong SAR, and Japan—achieved very high scores, which ranged from 598 (Chinese Taipei) to 570 (Japan). Students in England, the Russian Federation, and the United States achieved average scores of 513, 512, and 508, respectively. Students in Qatar had the lowest average score (307) on the international scale (Mullis et al., 2008; National Center for Education Statistics, 2010).

1.2.2 The Mathematics Curriculum

While, at the macro-level, Grades K to 12 mathematics curricula are relatively consistent in terms of content and difficulty across countries (Tatto, Lerman, & Novotná, 2009), the heterogeneous performance of students in different countries may be associated with differences in the topics included in the textbooks and/or grade-level mathematics curricula of each country. For example, Valverde, Bianchi, Schmidt, McKnight, and Wolfe's (2002) analyses of Grade 8 mathematics textbooks from countries participating in TIMSS assessments found that the books in some (albeit relatively few) countries covered more complex topics than the books from other countries. The more complex topics included "estimating computations" and "numbers and their properties." Mullis et al. (2000) noted considerable cross-national variability in the extent to which students participating in TIMSS 1999 met international mathematics performance benchmarks pertaining not only to the overall mathematics test but also to each item on that test.

1.2.3 The Quality of Mathematics Lessons

Both the TIMSS 1995 Video Study (Stigler, Gonzales, Kawanaka, Knoll, & Serrano, 1999) and the TIMSS 1999 Video Study (Hiebert et al., 2003) rated the quality of mathematics lessons (i.e., how well these lessons were being taught) in the countries participating in these studies. Although the rating results for each study should be interpreted with caution because of the small number of countries included in the ratings (in the case of the 1995 study) and the small subsamples of lessons from each country in the 1999 study, the differences in the cross-national ratings suggest that the quality of lessons (specifically how they are taught) is considerable enough to warrant further research.

During the TIMSS 1995 Video Study, an expert panel rated the overall quality of the samples of mathematics lessons drawn for the three participating countries—Germany, Japan, and the United States. The panel rated 51% of the lessons from Japan as medium quality and 39% as high quality. In the United States, 89% of the lessons were rated low quality; no lesson received a high rating. In Germany, low-quality lessons made up 34% of the whole sample while high-quality lessons made up 28% of the entire sample (Stigler & Hiebert, 1997).

Subsamples of Grade 8 mathematics lessons from six of the seven countries that participated in the 1999 study (Australia, the Czech Republic, Hong Kong SAR, the Netherlands, Switzerland, and the United States[1]) were rated for quality by a "mathematics quality analysis group." Quality was defined according to four precepts: coherence, presentation, student engagement, and overall quality. The rating scale ranged from 1 for low to 5 for high. Hong Kong SAR gained the highest average ratings: coherence (4.9), presentation (3.9), student engagement (4.0), and overall quality (4.0). The United States received the lowest ratings (3.5, 2.4, 2.4, and 2.3, respectively).

1.2.4 The Nature of Teacher Education Programs

The Organisation for Economic Co-operation and Development (OECD) (2005) case studies of recruiting, preparing, and retaining effective teachers in 25 countries showed that teacher education provision varied in important ways across countries. For example, the providers of teacher education differed from country to country. In some countries,

1 Japan was not included because a sample of Japanese lessons was coded for quality during the earlier TIMSS 1995 Video Study.

universities provided all teacher education. In others, teacher training colleges offered non-university levels of preparation. There were also countries where agencies outside the higher education system provided teacher education. The OECD report also revealed that some teacher education programs were combined with undergraduate preparation in the discipline students were being prepared to teach, while other programs provided teacher education (i.e., pedagogy) only after candidates had finished a first university degree in a subject-matter area. Some countries provided only one route to becoming a teacher, while others offered more than one route.

Variation in teacher education is a product not only of readily visible differences in organization and structure but also of divergent views (of, for example, educational experts, policymakers, and reformers) on how best to conduct the preparation of teachers. These views encompass the knowledge that is deemed most important to teach, the relationship between theory and practice, the relative importance of subject matter, pedagogy, and teacher understanding of students, and whether future teachers learn best through actual experience in classrooms (Schwille & Dembélé, 2007; Tatto, 2000, 2007).

This diversity is reflected in the terminology used across the field of teacher education (Eurydice, 2002; Stuart & Tatto, 2000; UNESCO, 1998). For example, the word "pedagogy" has a wide array of meanings, ranging from a narrow technical focus on teaching technique (as used in the United States) to a broad concern with everything that happens in the classroom, including its moral and philosophical underpinnings (Hamilton & McWilliam, 2001). The broader view is represented in European discourse on teacher education, where the term "general pedagogy" is typically used to designate all non-subject-matter theoretical aspects of teacher education programs. In the United States, these aspects are covered by the term "educational foundations."

1.2.5 The Content of Teacher Education Programs

Although experts may not be able to consensually define and measure all aspects of what it takes to teach well, all agree on the importance of subject-matter knowledge (Monk, 1994). But agreement ends there: marked differences exist among stakeholders on what knowledge is important for teachers to acquire, how teachers should acquire that knowledge, and how important that knowledge is to each teacher's success (Grossman, 1990).

Of particular importance to the debate on what should be taught in formal teacher education is the question of whether teachers who know the subject-matter content they are to teach can learn on the job everything else they need to teach well or whether they need to engage in formal teacher education (Darling-Hammond, Holtzman, Gatlin, & Vasquez Heilig, 2005). This debate tends, however, to ignore the relevance of what is known in Europe as *didactique* (Boero, Dapueto, & Parenti, 1996) and in the United States as *knowledge for teaching* or, to use educational psychologist Lee Shulman's (1987) term, *pedagogical content knowledge*. The importance that this latter type of knowledge holds for teaching well is highlighted in a German study which found that "when mathematics achievement in grade nine was kept constant, students taught by teachers with higher pedagogy content knowledge (PCK) scores performed significantly better in mathematics in grade ten" (Brunner et al., 2006, p. 62).

Pedagogical content knowledge is just one category within Shulman's (1987) teacher knowledge framework. However, it is an important one because, as Shulman explains, it is what allows teachers to effectively relay and make comprehensible to students subject-matter knowledge and curricular knowledge. Subject-matter (or content) knowledge is the set of fundamental assumptions, definitions, concepts, and problem-solving methods that constitute the ideas to be learned. Pedagogical content knowledge is evident when teachers use powerful analogies and examples to describe and explain aspects of the subject being learned. It is also evident when they draw on insights into what makes the learning of specific topics within the subject curriculum easy or difficult and then tailor their teaching accordingly, and when they actively appreciate the conceptions that students of different ages and backgrounds bring with them as they start to learn various subject-related topics in school.

A number of studies indicate that the mathematics content and pedagogy knowledge which teachers learn is frequently *not* the knowledge most useful for teaching mathematics (see, for example, Ball & Bass, 2000; Graham, Portnoy, & Grundmeier, 2002; Hill, Sleep, Lewis, & Ball, 2007). Various other studies (e.g., Even & Ball, 2009; Mullis et al., 2008) show that the mathematics knowledge of primary and secondary school students is weak in many countries, an outcome that may be, in part, a product of this situation. Also of relevance here is the claim that educational reforms directly affecting the mathematics preparation of teachers and the curriculum they are expected to teach are frequently prompted by mandates deployed with little or no empirical basis supporting their effectiveness (for examples, see Tatto, 2007). These changes have led, in some cases, to incoherent systems of teacher education and to increasing uncertainty about what mathematics teachers need to know and how teacher education can help them acquire such knowledge (Tatto, Lerner, & Novotná, 2009).

1.3 Research Questions

The above considerations led to formulation of three key research questions:

1. What are the policies that support primary and secondary teachers' achieved level and depth of mathematics and related teaching knowledge?
2. What learning opportunities, available to prospective primary and secondary mathematics teachers, allow them to attain such knowledge?
3. What level and depth of mathematics and related teaching knowledge have prospective primary and secondary teachers attained by the end of their preservice teacher education?

A common question across these three areas of inquiry (each of which is described in more detail below) concerned cross-national and intra-national variation: thus, how and to what extent do teacher education policy, opportunities to learn, and future teachers' mathematics subject and pedagogy knowledge vary across and within countries?

1.3.1 Research Question 1

Effort to answer this question required examination of national policies directed at mathematics teachers, including those pertaining to recruitment, selection, preparation, and certification. More specifically, this question called for collection of data pertaining to the following:

(a) The policies that regulate and influence the design and delivery of mathematics teacher education for future primary and secondary teachers;

(b) The institutions and programs charged with implementing these policies;
(c) The distinctive political, historical, and cultural contexts within each country that influence policy and practice in mathematics teacher education; and
(d) The policies in each country regarding standards for degrees, coverage of topics, certification practices, and the recruitment, selection, and preparation of future mathematics teachers.

1.3.2 Research Question 2

This question focused on the intended and implemented curriculums of teacher education at the institutional level, as well as the overall opportunities to learn embedded in these curriculums. The data gathered included:

(a) The kinds of institutional and field-based opportunities provided for future primary and secondary teachers;
(b) The enacted curriculums and standards of teacher education programs;
(c) The content taught in teacher education programs and how instruction is organized; and
(d) The qualifications and prior experiences of those responsible for implementing and delivering these programs.

1.3.3 Research Question 3

This question required examination of the *intended* and *achieved* goals of teacher education. Specifically, this question led to exploration and identification of the following:

(a) The mathematics content knowledge that future teachers are expected to acquire as an outcome of their teacher education;
(b) The depth of understanding of mathematics that they are expected to achieve;
(c) The mathematics teaching knowledge (i.e., content, pedagogy, curriculum) that future teachers have achieved by the end of their teacher education (i.e., the point at which they are considered "ready to teach");
(d) Other characteristics that might help explain future teachers' ability to gain mastery of this knowledge; and
(e) The beliefs about the nature of mathematics and about teaching and learning mathematics that future teachers hold at the end of their preparation.

1.4 The Design of TEDS-M

The conceptual framework, design, and methodology of TEDS-M are outlined in Appendix B of this report and thoroughly documented in various other reports (see Tatto, 2012; Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008), and we refer readers to them. However, descriptions of the sources from which study data were collected and the process used to draw samples of survey respondents provide important contextual information with respect to the content of this report and so are given here.

1.4.1 Data Sources

Data pertaining to the first research question were drawn from case study reports from each participating country and from questionnaires and interviews issued and conducted by the TEDS-M international study centers. Data relating to the second and third questions were gathered through four surveys developed by the international research centers and administered by the national research centers. The surveys targeted 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 preparing to teach mathematics.

1.4.2 Sampling Process

In most countries, TEDS-M implemented a two-stage random sampling design. First, the sampling unit of the IEA Data Processing and Research Center (DPC) worked with each participating country's national research center to select samples representative of the national population of "teacher preparation" (TP) institutions offering education to future teachers intending to teach mathematics at the primary and/or lower-secondary levels. Once an institution had been selected, all programs within that institution offering mathematics preparation were identified. These institutions (and programs) along with samples of educators and future teachers from within them were then surveyed. In many countries, all TP institutions had to be selected in order to achieve IEA sampling standards, and in the sampled institutions it was necessary for all but a few countries to survey all eligible educators and all eligible future teachers.

The national research centers in each country used the software package WinW3S to select the samples of programs, future teachers, and educators. Sampling errors were computed using balanced half-sample repeated replication (or BRR, a well-established re-sampling method). All countries participating in TEDS-M were required to provide complete national coverage of their national-desired target populations. However, in some cases, organizational and/or operational conditions made it difficult for the centers to obtain complete national coverage. These occurrences are annotated throughout this report.

1.5 Distinctive Characteristics of and Target Audiences for TEDS-M

The TEDS-M study is unique in several important respects. It is the first:

- IEA study conducted within the sphere of higher education;
- IEA study of teacher education;
- Cross-national study of teacher education designed to gather data from nationally representative probability samples on the knowledge outcomes of teacher education and on the possible determinants of those outcomes;
- Cross-national study of teacher education to integrate a specific subject matter (mathematics) with generic issues in teacher education policy and practice and to be conducted on a nationally representative basis; and
- International assessment of student learning in any field of higher education to employ representative national samples.

For educational policymakers, TEDS-M contributes data on institutional arrangements that are effective in helping teachers become sufficiently knowledgeable in mathematics and related teaching knowledge. For teacher educators who design, implement, and evaluate teacher education curriculums, TEDS-M contributes a shared language, a shared database, and benchmarks for examining teacher-education program designs against what has proved possible and desirable to do in other settings. For mathematics educators, TEDS-M provides a better understanding of what qualified teachers of mathematics are able to learn about the content and pedagogy of mathematics, as well as the arrangements and conditions needed for acquisition of this knowledge. For educators in general and for informed laypersons, TEDS-M provides a better understanding about how and what teachers learn as they prepare to teach.

1.6 Content of this Report

The rest of this report presents the findings of TEDS-M. Chapters 2 and 3 address Research Question 1. Chapter 2 compares national policies and employment conditions in teacher education across the participating countries. It also pays particular heed to the forces that shape the mathematics preparation of future teachers, including the organization and characteristics of teacher education at the national level. Chapter 3 provides "capsule" descriptions of teacher-education systems at the national level in each country. Taken together, Chapters 2 and 3 provide detail about the policy and systems of teacher education that serves as context for the findings of the various surveys.

The remaining chapters present the results of the national surveys used to address Research Questions 2 and 3. Chapter 4 summarizes the main characteristics of the institutions, programs, teacher educators, and future primary and lower-secondary teachers who responded to the TEDS-M questionnaires. The chapter also documents the variation observed across countries with respect to teacher education institutions, credentials granted, curriculum content, and the background characteristics of teacher educators and future teachers. Chapter 5 details the frameworks that TEDS-M used to measure future primary and lower-secondary teachers' mathematics content knowledge and mathematics pedagogy knowledge, and the results of these tests.

Chapter 6 includes findings concerning future teachers' beliefs about the nature of mathematics, about learning mathematics, and about mathematics achievement. Chapter 7 describes the theoretical framework, research questions, and domains used to study the opportunities to learn to teach mathematics that the various national teacher education programs offered future teachers.

The final chapter, Chapter 8, includes a discussion of the implications of the TEDS-M findings for policy and further research analysis. Appendix A contains a number of exhibits that complement the discussions in various chapters. Appendix B provides a detailed account of the methodology informing the study as well as descriptions of the research concepts underlying the study and of the methods used to implement the four surveys and to analyze and report the data. Appendix C lists and acknowledges the many people and organizations involved in designing and implementing TEDS-M and in analyzing and reporting its data.

References

Ball, D. L., & Bass, H. (2000). Interweaving content and pedagogy in teaching and learning to teach: Knowing and using mathematics. In J. Boaler (Ed.), *Multiple perspectives on the teaching and learning of mathematics* (pp. 83–104). Westport CT: Ablex.

Boero, P., Dapueto, C., & Parenti, L. (1996). Didactics of mathematics and the professional knowledge of teachers. In A. J. Bishop, M. A. Clements, C. Keitel, J. Kilpatrick, & C. Laborde (Eds.), *International handbook of mathematics education* (pp. 1097–1121). Dordrecht, the Netherlands: Kluwer Academic Publishers

Brunner, M., Kunter, M., Krauss, S., Klusmann, U., Baumert, J., Blum, W., ... Tsai, Y.-M. (2006). Die professionelle Kompetenz von Mathematiklehrkräften: Konzeptualisierung, Erfassung und Bedeutung für den Unterricht; eine Zwischenbilanz des COACTIV-Projekts [The professional competencies of mathematics teachers: Conceptualization, assessment, and significance for instruction: An interim review of the COACTIV project]. In M. Prenzel & L. Allolio-Näcke (Eds.), *Untersuchungen zur Bildungsqualität von Schule: Abschlussbericht des DFG-Schwerpunktprogramms* [Studies on the quality of school education: Final report of the DGF Priority Program] (pp. 54–82). Münster, Germany: Waxmann.

Darling-Hammond, L., Holtzman, D. J., Gatlin, S. J., & Vasquez Heilig, J. (2005). Does teacher preparation matter? Evidence about teacher certification, Teach for America, and teacher effectiveness. *Education Policy Analysis Archives*, *13*(42). Available online at http://epaa.asu.edu/epaa/v13n42/v13n42.pdf

Eurydice. (2002). *Key topics in education, Vol. 3. The teaching profession in Europe: Profile, trends and concerns*. Brussels, Belgium: Author.

Even, R., & Ball, D. L. (2009). *The professional education and development of teachers of mathematics: The 15th ICMI Study*. New York: Springer.

Graham, K. J., Portnoy, N., & Grundmeier, T. (2002). Making mathematical connections in programs for prospective teachers. In D. S. Mewborn, D. Y. White, H. G. Wiegel, R. L. Bryant, & K. Nooney (Eds.), *Proceedings of the twenty-fourth annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (Vol. 4, pp. 1930–1932). Columbus, OH: ERIC Clearinghouse for Science Mathematics and International Education.

Grossman, P. L. (1990). *The making of a teacher: Teacher knowledge and teacher education*. New York: Teachers College Press.

Hamilton, D., & McWilliam, E. (2001). Ex-centric voices that frame research on teaching. In V. Richardson (Ed.), *Handbook of research on teaching* (4th ed., pp. 17–47). Washington, DC: American Educational Research Association.

Hiebert, J., Gallimore, R., Garnier, H., Bogard Givvin, K., Hollingsworth, H., Jacobs, J., … Stigler, J. (2003). *Teaching mathematics in seven countries: Results from the TIMSS 1999 Video Study*. Washington DC: National Center for Education Statistics. Available online at http://timssvideo.com/sites/default/files/TIMSS%201999%20Math%20Report.pdf

Hill, H. C., Sleep, L., Lewis, J., & Ball, D. L. (2007). Assessing teachers' mathematical knowledge: What knowledge matters and what evidence counts? In F. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 111–156). Charlotte, NC: Information Age Publishing.

Monk, D. H. (1994). Subject area preparation of secondary mathematics and science teachers and student achievement. *Economics of Education Review*, *13*, 125–145.

Mullis, I. V. S., Martin, M. O., & Foy, P., with Olson, J. F., Preuschoff, C., Erberber, E., … Galia, J. (2008). *TIMSS 2007 international mathematics report: Findings from IEA's Trends in International Mathematics and Science Study at the fourth and eighth grades*. Chestnut Hill, MA: Boston College. Available online at http://timss.bc.edu/TIMSS2007/mathreport.html

Mullis, I. V. S, Martin, M. O, Gonzalez, E. J, Gregory, K. D., Garden, R. A., Kathleen M., … Smith, T. A. (2000). *TIMSS 1999 international mathematics report: Findings from IEA's repeat of the Third International Mathematics and Science Study at the eighth grade.* Chestnut Hill, MA: Boston College. Available online at http://timss.bc.edu/timss1999i/math_achievement_report.html

National Center for Education Statistics (NCES). (2010). *Trends in International Mathematics and Science Study (TIMSS)*. Washington, DC: United States Department of Education. Retrieved from http://nces.ed.gov/timss/

Organisation for Economic Co-operation and Development (OECD). (2005). *Attracting, developing, and retaining effective teachers. Final report: Teachers matter*. Paris, France: Author.

Schwille, J., & Dembélé, M. (2007). *Global perspectives on teacher learning: Improving policy and practic*e (Fundamentals of Educational Planning, No. 84). Paris, France: International Institute for Educational Planning, UNESCO.

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*, 1–22.

Stigler, J. W., Gonzales, P., Kawanaka, T., Knoll, S., & Serrano, A. (1999). *The TIMSS Videotape Classroom Study: Methods and findings from an exploratory research project on eighth-grade mathematics instruction in Germany, Japan, and the United States.* Washington, DC: National Center for Education Statistics.

Stigler, J. W., & Hiebert, J. (1997). Understanding and improving classroom mathematics instruction. *Phi Delta Kappan*, *79*, 14–21.

Stuart, J., & Tatto, M. T. (2000). Designs for initial teacher preparation programs: An international view. *International Journal of Educational Research*, *33*, 493–514.

Tatto, M. T. (2000). *Assessing what we know about teacher quality and development: Empirical indicators and methodological issues in comparative perspective.* Report commissioned by the Board on Comparative and International Studies in Education (BICSE) National Academy of Sciences/ National Research Council, Washington, DC, USA.

Tatto, M. T. (2007). *Reforming teaching globally*. Oxford, UK: Symposium Books (reprinted in 2009 by Information Age Publishers).

Tatto, M. T. (2012). *Teacher Education and Development Study in Mathematics (TEDS-M): Technical report.* Amsterdam, the Netherlands: International Association for Educational Achievement (IEA).

Tatto, M. T., Lerman, S., & Novotná, J. (2009). Overview of teacher education systems across the world. In R. Even & D. L. Ball (Eds.), *The professional education and development of teachers of mathematics: The 15th ICMI Study* (pp. 15–23). New York: Springer.

Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). *Teacher Education and Development Study in Mathematics (TEDS-M): Conceptual framework.* Amsterdam, the Netherlands: International Association for Educational Achievement (IEA). Available online at http://teds.educ.msu.edu/framework.asp

UNESCO. (1998). *World education report: Teachers and teaching in a changing world.* Paris, France: Author.

Valverde, G. A., Bianchi, L. J., Schmidt, W. H., McKnight, C. C., & Wolfe, R. G. (2002). *According to the book: Using TIMSS to investigate the translation of policy into practice in the world of textbooks.* Dordrecht, the Netherlands: Kluwer Academic Publishers.

CHAPTER 2:

TEACHER EDUCATION POLICIES AND EMPLOYMENT CONDITIONS IN TEDS-M COUNTRIES

2.1 Chapter Overview

An important aim of TEDS-M is to understand how policies at national and provincial levels may influence the structure and practices of teacher education programs and the knowledge, abilities, and beliefs of future teachers enrolled in them. The purpose of this chapter is to summarize these policies, while focusing on three key aspects pertaining to them:

- The structure and organization of teacher education systems in the countries that participated in TEDS-M (Section 2.2);
- Important features of the policy context, such as the employment and working conditions for which teachers are prepared (Section 2.3);
- National arrangements for quality assurance in teacher education (Section 2.4).

It is important to note that this chapter also provides a summary of the companion TEDS-M policy report, *National Policies and Regulatory Arrangements for the Preparation of Teachers in TEDS-M Countries* (Ingvarson, Schwille, Tatto, Rowley, Senk & Peck, forthcoming). That report is based on the following:

- National reports prepared by the TEDS-M national research coordinators from each of the countries in response to a structured list of questions provided by the international research centers;
- A survey concerning teacher-education policies in the respective countries.

When reading this chapter, please keep in mind that data for this chapter were gathered in 2008 and describe the situation as it applied at that time. Some TEDS-M countries have experienced major changes to their teacher education systems since then. Also keep in mind that the purpose and organization of teacher-education programs in countries participating in TEDS-M vary markedly, both between and within countries. One reason is because teacher education programs reflect differences in the structure of primary and secondary education across countries.

In order to describe these differences (as well as similarities) more precisely, TEDS-M uses specific terminology in relation to the structure and organization of teacher education. This terminology is detailed in the following subsection.

2.1.1. TEDS-M Organizational Terminology

TEDS-M uses three key terms to denote the structure and organization of teacher education. They are program, program-type, and program-group.

1. *Program* refers to a course of study leading to a teaching credential.
2. *Program-type* refers to clusters of programs that share similar purposes and structural features, such as the credential earned, the type of institution in which the program-type is offered, whether the program-type is concurrent or consecutive, the range of school grade levels for which teachers are prepared, the duration of the programs in the program-type, and the degree of subject-matter specialization for which future

teachers are prepared. In other words, program-type refers to the organizational features that distinguish between pathways to becoming qualified to teach.

For example, in Poland, one of the 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 that are organized for future teachers in this program-type have certain attributes in common, regardless of which university offers them. Some of these common features are different from the common features of other program-types in Poland, such as the ones that prepare mathematics specialists to teach in Grade 4 and above.

In contrast, the word *program* in TEDS-M refers only to how a program-type has been implemented in one particular institution. In short, the terms program and program-type are meant to clarify the everyday use of the term program in teacher education. This everyday usage is ambiguous because it can refer either to teacher education as organized in one particular institution or to closely related offerings at multiple institutions—a distinction for which TEDS-M requires clarity. Thus, whatever National Taiwan Normal University offers to qualify future teachers 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 Taiwan (Chinese Taipei). Multiple programs of the same type in multiple institutions typically make up a program-type.[1] In short, programs are nested within program-types.

3. Because of the need to provide a more comparable and sufficiently large grouping of future teachers for analysis across countries, TEDS-M further aggregates program-types into *program-groups*. The concepts of *program-type* and *program-group* are both essential to the purposes of TEDS-M. Each program-type is a recognized, visible part of the actual institutional structure of teacher education in each country. Knowledge of which program-types were included in TEDS-M for each country is necessary for understanding the content of this report. In contrast, the term *program-group* is used in TEDS-M to divide the target population of future teachers into categories that are more comparable for cross-national analysis. Program-groups have no recognized existence outside TEDS-M. When used together, the terms *program-type* and *program-group* provide a means of explaining and justifying what TEDS-M has done and found more precisely than would be otherwise possible.

2.2 Structure and Organization of Teacher Education Program-Types

Exhibit 2.1 lists all the program-types included in the TEDS-M target population and shows how they differ within and between countries. Although the names of program-types vary from country to country, the characteristics and purpose of program-types in different countries are often similar. For example, the Elementary Teacher Education program-type in Chinese Taipei has similar characteristics and purposes to the Bachelor of Elementary Education program-type in the Philippines. The following subsections provide a discussion of the basic sources of variation in Exhibit 2.1 (as identified by the column headings).

1 However, there were a few instances of just one institution in a country offering a program-type (e.g., University of Botswana and the National Institute of Education in Singapore). In these instances, program and program-type are the same.

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

2.2.1 Concurrent and Consecutive Program-Types

One way in which program-types differ within and across the TEDS-M countries relates to whether they are *concurrent* or *consecutive*. Concurrent program-types grant future teachers a single credential for studies in subject-matter content, pedagogy, and other courses in education; these components are all included within the first phase of post-secondary education and sanctioned by a single credential. In contrast, consecutive teacher education program-types require completion of two phases of post-secondary education; first, an initial university degree with specialization in the subject-matter that the future teacher is being prepared to teach, followed by a separate second phase focused mostly on pedagogy and practicum and sanctioned by a second credential.

Most program-types in the TEDS-M countries are concurrent, but consecutive program-types exist and were surveyed in Georgia, Malaysia, Norway, Oman, Singapore, Thailand, and the United States. The only country for which this distinction does not closely apply is Germany, where preparation for teaching is spread across two phases similar to those of other consecutive program-types. The first phase takes place in universities and ends with the first state examination. The second—practical—phase is provided in special institutions by each federal state and leads to the second state examination. (Passing the latter examination is recognized in the international ISCED classification of post-secondary programs as equivalent to reaching Level 5A, a second university degree.) Unlike in other consecutive programs, the first phase includes, in addition to coursework in academic subjects, classes in subject-specific pedagogy and general pedagogy. During the second phase, future teachers pursue mainly pedagogical study while simultaneously taking full responsibility for teaching assigned classes in a primary or secondary school.

Although the distinction between concurrent and consecutive program-types has been used widely in the literature, few systematic cross-national studies have investigated how concurrent differs from consecutive in curricula and in practice, except for the fact that consecutive program-types tend to place all or most of their subject-matter content early in the program-type and to place pedagogical content and field experience toward the end. However, the differences in course content may not be that great, especially when, as is commonly the case, concurrent and consecutive programs are offered in the same institution. A third type of program (i.e., additional to consecutive and concurrent programs) is now widely available in some countries such as the United States. These *school-based* program-types take more of an apprenticeship approach to learning to teach. They are not represented in the TEDS-M database.

2.2.2 School Grade Levels for which a Program-Type Prepares Teachers

Another obvious way in which to classify teacher education program-types is to determine whether they prepare teachers for primary or secondary schools. However, it quickly became apparent within the context of TEDS-M that this is an over-simplification. The terms *primary* and *secondary* do not mean the same thing from country to country. Instead, the grade spread in teacher education program-types reflects the structure of schooling in each country. The grade spread is also a 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 well as committed to serving all children, not just the élite.

For example, several countries, including Chinese Taipei, Georgia, and Malaysia, have primary program-types that prepare generalist teachers to teach from Grades 1 to 6 because these grades constitute primary school in those countries (see Exhibit 2.1). In contrast, in most German states, primary schools are limited to Grades 1 to 4 where mathematics is taught by generalist teachers. Thereafter, mathematics is taught by specialist teachers of mathematics. Future generalist primary teachers in Germany usually undertake a different type of teacher education program from that taken by future specialist teachers of mathematics.

Chile and Norway have program-types that prepare teachers to teach Grades 1 to 8 and 1 to 10 respectively, reflecting once again the structure of schooling in those countries. These program-types make little or no distinction between the preparation of teachers for the early grades and for the middle grades. This situation is radically different from that in countries such as Chinese Taipei and the Philippines, where the transition from Grade 6 to Grade 7 provides a clean break between primary school and secondary school.

These differences in grade spread were a challenge for TEDS-M in terms of deciding which instruments to administer to which future teachers. The TEDS-M cross-national assessment instruments were developed to assess mathematics teaching knowledge at two levels of the mathematics curriculum: content internationally judged appropriate for those preparing to be primary and lower-secondary teachers respectively. The right-hand column in Exhibit 2.1 shows that future teachers preparing only for grades considered primary were administered the primary assessments; likewise, future teachers preparing only for grades considered secondary were given the secondary assessments.

Future teachers in program-types preparing for both levels were randomly divided into two halves, one half receiving the primary assessment and the other half the secondary assessment. For the rest of this report, therefore, it is essential to remember that program-types from countries that overlap the usual primary–secondary divide appear in both primary and secondary exhibits. (These countries include Chile, Germany, Norway, Poland, Thailand, and the United States.) Nevertheless, while completing their teacher education, the future teachers in each randomly selected half appearing in a primary-level exhibit experienced exactly the same program-type as the other randomly selected half appearing in the secondary-level table.

2.2.3 Program-Type Duration

Duration is another basis on which to classify program-type. Most program-types preparing primary teachers in TEDS-M are four years long. However, as Exhibit 2.1 shows, there is some variation across countries. Concurrent program-types commonly require four years, while for consecutive program-types the first phase typically lasts three or four years and the second phase one year. Once again, Germany is an exception. There, the first phase is usually 3.5 or 4.5 years and the second 2 years.

Duration of initial teacher education is of major concern to policymakers, primarily because of cost. Full-time program-types of initial teacher preparation are expensive (see, for example, Schwille & Dembélé, 2007). Longer program-types are ordinarily more expensive both in terms of institutional costs and in terms of foregone income and other expenses borne directly by the student. However, while shorter program-types may be cheaper, they may be less effective (e.g., more teachers requiring professional development, remediation, or termination).

The documents collected during the TEDS-M survey show that, in recent decades, some countries have increased program-type duration while others have reduced it. In some cases (especially school-based rather than university-based program-types), these changes have tended toward relatively short terms of formal training accompanied by longer periods of internship and/or probation. Comparable cross-national data on duration and outcomes could provide a basis for cost-effectiveness studies in teacher education.

2.2.4 Subject-Matter Specialization

As indicated earlier, program-types can also be classified according to whether they prepare *generalist* teachers or *specialist* teachers of mathematics. In most of the TEDS-M countries, primary school teachers are prepared as generalists to teach most, if not all, the core subjects in the school curriculum. (For purposes of precision, future teachers in TEDS-M are classified as specialists if they are prepared primarily to teach one or two subjects and as generalists if prepared primarily to teach three or more subjects.) However, there are countries that also prepare specialist teachers of mathematics to teach from Grades 4, 3, or even 1. They include Germany, Malaysia, Poland, Singapore, Thailand, and the United States. In lower-secondary school, specialization is more the norm across countries, although in many cases the "norm" means teaching not one but two main subjects, such as mathematics and science.

If the degree of specialization were not kept in mind, it would be misleading to compare program-types that differ in this respect. A future teacher being prepared to specialize in the teaching of mathematics will usually be expected to learn more mathematics content knowledge than a future teacher being prepared to teach more than one subject. Exhibit 2.1 shows the degree of specialization in each of the program-types included in TEDS-M.

2.2.5 Relative Size of Different Program-Types

Paying attention to the relative size of the program-types is essential to understanding the structure of teacher education in any one country. Should this consideration not be kept to the fore, readers might easily assume that some program-types are bigger and less marginal than they actually are with respect to meeting the demand for new teachers. The exhibits for each country in Chapter 3 show how the distribution of future teachers in the TEDS-M target population varies by program-type. For each country, the associated exhibit indicates which program-types produce the most graduates and which the least. In Norway, for example, the importance of not confusing the two main program-types is made clear when it becomes evident that, of the program-types, ALU with the mathematics option is a much smaller program-type than the other (ALU without the mathematics option). The other two secondary program-types in Norway are very marginal in terms of numbers. In fact, in most countries, certain program-types are much larger than others and could possibly have more impact on the composition of the teacher workforce.

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 are unbiased estimates of the actual total number of future teachers in the target population broken down by program-type. It is unlikely that these estimates could be derived from any source other than TEDS-M—even within a single country. This point is especially applicable to preparation of teachers for lower-secondary school. The TEDS-M team was not searching for the total number of future teachers preparing to become lower-secondary teachers—a figure that might be more easily obtained. Instead, the team was interested in finding out how many future lower-secondary teachers were preparing to teach mathematics as either their only or one of their two main teaching subjects. National educational statistics are rarely maintained on the number of future secondary teachers by subject-matter specialization.

2.2.6 Grouping Program-Types for Cross-National Analysis

The TEDS-M team faced a major challenge in finding a defensible way to make comparisons between teacher education program-types across countries. It was apparent that simple "league tables" comparing whole countries on aggregate measures such as the mathematical knowledge of future primary or secondary teachers could lead to unfair or invalid interpretations if no account was taken of differences in the structure of teacher education across the participating countries.

To meet this challenge, the TEDS-M team grouped together for analysis program-types with similar purposes and characteristics. This was done separately: first, for all future teachers who were administered the primary instruments; and second, for all teachers who were administered the secondary instruments. Of the characteristics listed in Exhibit 2.1, two turned out to be those most relevant for clarifying similarities and differences in the teaching roles for which future teachers are prepared. These were *grade span* and *degree of specialization*.

The TEDS-M team grouped the primary program-types according to whether they prepare specialist teachers of mathematics or generalist teachers. Program-types at primary level that prepare generalist teachers were then subdivided into three groups according to the highest grade level for which they offer preparation: (1) program-types that prepare teachers to teach no higher than Grade 4, (2) program-types that prepare teachers to teach no higher than Grade 6, and (3) program-types that prepare teachers to teach no higher than Grade 10. The specialist teachers of mathematics constituted Group 4. At lower-secondary level, program-types were placed in two groups, according to whether graduates from those program-types would be eligible to teach no higher than Grade 10 (Group 5) or up to the end of secondary schooling (Group 6). The six program-type groups arising out of this classification process (i.e., according to grade levels for which preparation is offered and according to a degree in the specialist subject) were named as follows.

Program-type groups, primary level

1. Lower-primary generalists (Grade 4 maximum)
2. Primary generalists (Grade 6 maximum)
3. Primary/lower-secondary generalists (Grade 10 maximum)
4. Primary school mathematics specialists

Program-type groups, lower-secondary level

5. Lower secondary (to Grade 10 maximum)—mostly specialists
6. Lower and upper secondary (to Grade 11 and above)—all specialists.

Note that while all the program-types in Group 6 prepare specialist teachers of mathematics, this is not the case for program-types in Group 5. As mentioned earlier, teachers teaching mathematics to lower-secondary students in some countries, such as Norway and Chile, are trained as generalists. However, because such cases were relatively few, they were included in Group 5.

Exhibit 2.1 shows the group to which each program-type was assigned. Here we can see, for example, that three different program-types in Germany were assigned to Group 1 because each prepares generalist teachers to teach no higher than Grade 4. In later chapters, we report the results of TEDS-M with respect to knowledge, beliefs, and opportunities to learn within the context of program-groups. Thus, in the case of Germany, all such data for the program-types belonging to Group 1 are aggregated and presented together in tables and graphs. Results for individual program-types (as well as individual programs) are not reported.

It is important to note that some program-types were assigned to more than one program group. These were the program-types where the TEDS-M sample was randomly split into halves so that future teachers from those programs could complete both the primary and secondary surveys. This procedure was appropriate because, according to the countries' own policies defining the program-type, these teachers were becoming qualified to teach at both levels.

2.2.7 Locus of Control with Respect to the Organization of Teacher Education

In some countries, policymaking in teacher education is highly centralized, with many decisions about the organization of teacher education being made by policymakers in the national or provincial ministries of education. In other countries, many of the same decisions are left to the institutions of teacher education. The following are examples of program features that are decided in some countries at the national level and in others at the local level.

- *Program goals and emphases*—for example, whether programs embody a vision of good teaching that serves to unify its curriculum and practices in a coherent fashion; also whether programs uphold "traditional" best practices or are intended to advance a particular reform.
- *Duration and other characteristics of practicum/field experience*—when scheduled, where, and especially how and by whom practicum assignments are assigned, mentored, and assessed; also nature of responsibilities assigned to future teachers during their practicums, such as observation, tutoring small numbers of students, assisting the teacher in other ways, and eventually taking the lead in teaching a whole class.
- *Requirements governing selection of future teachers for a program*—for example, enrollment limited to applicants with desired levels of prior academic achievement and other special qualifications.
- *Accountability to external authorities*—evident in the quality assurance policies discussed later in this chapter.
- *Qualifications required of teacher educators*—policies governing possession of advanced degrees and requirements for teaching experience in primary or secondary school.

Countries with the most decentralized systems of teacher education governance include Canada, Chile, Norway, Switzerland, and the United States.

2.3 Employment and Working Conditions for Practicing Teachers

TEDS-M made it possible to document the wide variation in the jobs, careers, and working conditions for which teacher education programs prepare their future teachers (Ingvarson et al., forthcoming). In order to facilitate discussion of these matters in this present report, we have condensed the information provided by the NRCs in their national reports and organized it under the following headings: (a) teacher employment systems, (b) teacher working conditions, (c) teacher salaries and incentives, and (d) teacher supply and demand.

2.3.1 Policies Concerning Systems of Teacher Employment

Two major systems of teacher employment in the world have become known as career-based and position-based (Organisation for Economic Co-operation and Development [OECD], 2005).

The career-based system is one where teachers are expected to remain, throughout their working life, in one well-organized public or civil service, integrated at the national or provincial level. Promotion follows a well-defined path of seniority and other requirements, and deployment of teachers is based on bureaucratic procedures rather than the discretion of local administrators with hiring authority. In such a system, entry normally occurs at a young age and is based on academic credentials and/or examinations. Countries able to afford career-based staffing can generally avoid major teacher supply problems.

In position-based systems, teachers are hired into specific teaching positions within an unpredictable career-long sequence of assignments. Access is more readily open to applicants of diverse ages and atypical career backgrounds. Movement in and out of teaching, to raise children or pursue other opportunities, is possible. Selection for positions is decentralized, with school administrators or local education authorities responsible for hiring teachers. Position-based systems typically have more problems attracting and retaining teachers, especially in areas such as mathematics, where people with the requisite skills do not necessarily go into teaching because they are in demand for jobs elsewhere.

Among the countries participating in TEDS-M, Singapore, Oman, Spain, Thailand, and (until recently) Chinese Taipei are primarily career based, signaling a likely commitment to lifelong employment for teachers within a highly organized public service. These systems are more likely than the position-based systems to invest in initial teacher training, because they can be more confident of retaining teachers for life and therefore more assured of a lifelong return on their investment in the form of the teachers' services. In contrast, Canada, Georgia, Norway, Switzerland, and the United States are primarily position based, with individuals moving in and out of teaching on a relatively short-term basis. Many graduates of such systems never occupy a teaching position, as evidenced in, for example, the national reports from Chinese Taipei and the United States. Germany and Poland are examples of hybrid systems.

2.3.2 Teacher Working Conditions

Countries where teaching conditions are relatively favorable can readily attract the required number of talented, highly motivated teachers. In those countries where conditions are unfavorable, recruiting teachers tends to be difficult. In principle, future teachers are prepared to face these conditions. In some countries, they enter classrooms that are well-resourced and in which they will be expected to use sophisticated ICT equipment effectively. In other locations, they need to be prepared to deal, as effectively as possible, with overcrowded classrooms lacking all kinds of resources—furniture, books, paper, and the like—and often inadequately protected against bad weather and noise.

The TEDS-M national reports from Botswana and the Philippines tell of such conditions. In Botswana, for example, the challenges include heavy workloads, shortages of teaching and learning resources, large class sizes in some areas, an insufficient number of classrooms, and considerable diversity in student abilities and home languages. The more affluent countries of Germany, Spain, Switzerland, and Chinese Taipei were much less likely to report difficult working conditions. Chile is more in the middle range in these respects, and the United States is an example of a country with such a high degree of inequality that it is difficult to say whether conditions are generally more favorable or unfavorable. The national report for the United States argued that unfavorable conditions, where they exist, make it difficult to recruit teachers and contribute to high teacher turnover.

2.3.3 Teacher Salaries and Incentives

TEDS-M countries ranged from those where teaching is selective, well-compensated, and highly regarded, to countries with less selectivity, low salaries, and low status. Chinese Taipei is an example of a country in which the government has had a longstanding policy of providing and supporting favorable conditions for teachers. Their benefits have included competitive salaries, comprehensive health, disability, and life insurance, summer and winter vacations under a full-year salary, retirement pensions, and various special bonuses and allowances (e.g., marriage bonus, birth allowance, funeral allowance, allowance for children's education, and parental leave). Singapore is another country where the incentive policies are very favorable and competitive relative to other occupations in both the public and private sectors.

In other countries, the picture is more mixed. German salaries are relatively high on average compared to other OECD countries, but not very competitive with respect to private-sector occupations in Germany that also require university degrees. Poland is an example of a country where salaries used to be very low, but which has seen substantial increases since the end of the Communist era.

There is a trend in some countries toward giving local educational administrators and authorities the power to more readily increase incentives to attract and retain teachers. Malaysia is a good example of a country that provides special incentives for certain teaching specialties and assignments (e.g., mathematics teachers and teachers in remote areas). In still other countries, Thailand for example, salaries are low compared to other occupations with which teaching most competes, but because teaching is a career-based occupation offering secure lifelong employment, long vacations, and prescribed avenues of advancement, it still has considerable appeal. In contrast, the salary situation in the Philippines is so bad that finding a solution is proving difficult. At the time the Philippines submitted their TEDS-M country report, salaries were close to the poverty threshold, with new teachers receiving a salary of US$194 per month compared to the poverty threshold of US$156. Among the proposals to rectify this situation is a recent one calling for mathematics and science teachers to be included in a protected category of scientific and technical workers whose salaries have to be funded above a certain level.

2.3.4 Teacher Supply and Demand

Although the TEDS-M national reports revealed a satisfactory supply of generalist teachers, most indicated that their teacher workforce is imbalanced with respect to supply, and in ways that vary from country to country. Countries tending toward balance include Singapore, Canada (but with uneven distributions), Germany (but with predicted future shortages), Switzerland (but with scattered shortages), and Chile (but with some shortages). Other countries tend to have an oversupply of applicants and/or fully qualified teachers without jobs and/or even placed in overstaffed schools; only Chinese Taipei and Poland reported surpluses at both primary and secondary levels.

More typical are countries that—in various ways—produce enough, or more than enough, generalist teachers for primary schools, but are searching for ways to increase the number of well-qualified mathematics specialist teachers for lower-secondary and, in some cases, upper-primary school as well. These countries include Botswana, Malaysia, Norway, Oman, Philippines, and Thailand. Spain also reported a surplus of primary teachers, but was not able to report on its secondary school teachers. Georgia said it had both oversupply and shortages in certain subject areas. The four federalist countries (Canada, Germany, Switzerland, and the United States) all reported a good deal of variation among their constituent units in their needs for teachers.

2.4 Quality Assurance in Teacher Education

International interest in policies that promote teacher quality has increased markedly in recent years (OECD, 2005; Tatto, 2007). Policymakers, faced with mounting evidence that the most important in-school influence on student achievement is teachers' knowledge and skill (see, for example, Hanushek, 2004; Hattie, 2008), are paying closer attention to strategies likely to recruit, prepare, and retain the best possible teachers.

This section focuses on policies for assuring the quality of teacher education programs in the 17 countries participating in TEDS-M.[2] It provides a summary of the nature and strength of quality assurance arrangements in each participating country. The information provided in this section makes it possible to explore, in later chapters, relationships between quality assurance policies and teacher education outcomes.

As mentioned earlier, TEDS-M grew out of an interest in exploring why student achievement in mathematics in international studies such as IEA's TIMSS varies from country to country. One obvious hypothesis is that the variation in student achievement might be due to variation in teacher education systems, particularly policies for assuring the quality of future teachers and teacher education programs. To explore this relationship, the TEDS-M team found it necessary to first uncover appropriate and economical ways of classifying and summarizing quality assurance systems. They determined that the key components of quality assurance systems include:

- *Recruitment and selection:* the focus here is on the policies and agencies a country has in place to monitor and assure the quality of entrants to teacher education.

2 The information contained here is based on the reports submitted by each country. Condensed copies of these reports will be found in the TEDS-M encyclopedia (Schwille, Ingvarson, & Holdgreve-Resendez, forthcoming). Writers of these reports followed guidelines provided by the TEDS-M research team. These procedures are described in detail in a companion volume of the TEDS-M report series (Ingvarson et al., forthcoming).

- *Accreditation of teacher education institutions:* the focus here is on the policies and agencies a country has in place to monitor and assure the quality of teacher education institutions and their programs.
- *Entry to the teaching profession:* the focus here is on the policies and agencies a country has in place to ensure that graduates are competent and qualified before gaining certification and full entry to the profession.

These are the three main mechanisms by which countries seek to assure the quality of future teachers, and each country deals with them in its own way. Some countries have concerted policies to assure the attractiveness of teaching 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.

An increasing trend is for countries to establish external accreditation agencies with responsibility for conducting independent evaluations of teacher education programs. Another trend is to require graduates of teacher education programs to meet additional criteria, such as passing tests of subject-matter knowledge or successfully completing a period of induction or probationary teaching in schools before gaining professional certification.

2.4.1 Recruitment and Selection of Future Teachers

2.4.1.1 Enrollments in teacher education

Based on the relevant information in the country reports, the TEDS-M research team classified the participating countries according to the strength and locus of control of policies concerning teacher recruitment, supply, and the number of available teacher education places for teacher education students.[3]

Exhibit 2.2 categorizes the TEDS-M countries according to the extent to which government agencies exert control over recruitment and governance policies pertaining to teacher supply. In countries with strong control, such as Singapore, national or state governments match the number of places to the number of teachers that the school system needs. They may do this by limiting funding to a specified number of places in each teacher education institution. National government or quality assurance agencies may also lay down requirements or standards for students to gain entry to professional preparation programs. In Malaysia, the Ministry of Education determines the number of teaching posts based on an assessment of the number of teachers needed to cover each subject area in schools nationwide.

Exhibit 2.2: Recruitment/governance: extent of control over total number of places available for teacher education students

Level of Control	Countries
Strong control	Botswana, Chinese Taipei, Malaysia, Oman, Singapore
Mixed control	Canada,* Germany, Poland, Russian Federation, Thailand
Weak control	Chile, Georgia, Norway, Philippines, Spain, Switzerland, United States

Note: * Although Canada did not meet the sampling requirements for future teachers in TEDS-M, it did provide a country report and is therefore included in this section of the report.

3 The Russian Federation did not provide a country report. This section relies on information provided by Burghes (2008) and websites for the Ministry of Education and Sciences and the Federal Education and Science Supervision Agency.

In countries with weak controls, universities have few limits or quotas on the number of future teachers they can enroll. Countries where control is more localized are more likely to allow institutions to determine the number of students who enroll in their teacher education programs and/or to have a policy of encouraging alternative providers of teacher education instead of traditional providers such as universities. Spain reported a large over-supply of graduates from its schools of primary teacher education and its faculties of education, which are relatively autonomous.

Quotas exist in some Canadian jurisdictions, but they do not bind universities. Universities can determine the number of places for teacher education students. There is a major oversupply of teachers in several provinces and a wide range of academic achievement among applicants for teacher education places in different universities. The situation in Germany, Poland, and Thailand is also mixed. Although Germany and Switzerland, for example, have open-entry policies (every student who has successfully passed the *Abitur* or the *Matura*, the high-school exit examinations, has a legal right to enroll at university), the academic requirements for graduation from the secondary schools are relatively high (students who pass the Abitur are in the top 30% of students in their age cohort).

2.4.1.2 Teaching's attractiveness as an occupation and a career

Countries participating in TEDS-M were also classified according to the policies they have in place to maintain and promote the appeal and status of teaching relative to other career choices. Countries where teaching is a desirable career option have policies in place to ensure that teaching is an attractive occupation to people with the capacity to become effective teachers. These attractions include job security, pensions, and other like benefits. Demand for places from abler graduates in these countries is high. Exhibit 2.3 categorizes the TEDS-M countries on the basis of the content in the country reports which focused on the appeal that teaching holds within the job marketplace.

Exhibit 2.3: Attractiveness and status of primary and secondary teaching as a profession and as a career

Attractiveness/Status	Countries
High	Canada, Chinese Taipei, Singapore
Mixed	Botswana, Germany, Malaysia, Oman, Poland, Russian Federation, Spain, Switzerland, United States (secondary)
Low	Chile, Georgia, Norway, Philippines, Thailand, United States (primary)

There is a strong demand for teacher education places in Botswana, Canada, Chinese Taipei, and Singapore from abler high school and university graduates. These countries are characterized by strategies deliberately designed to maintain or improve teacher quality. In Singapore, for example, future teachers not only receive free university education but are also paid a stipend while learning. Salaries for beginning teachers, relative to other graduate salaries, are high. Working conditions in schools are supportive of good teaching. Career prospects as a teacher are good—the ratio of final salaries to starting salaries is comparatively high. Entrants to teacher education programs in these countries are above-average to high achievers in secondary schools, relative to their age cohort. In Chinese Taipei, the attractiveness of teaching resulted in a surplus of teachers in the recent past. As a result, the Ministry of Education moved to decrease the number of admissions to the normal universities and the universities of education, which prepare large numbers of future teachers, by 50% in three years beginning in 2004. While the McKinsey Report (Barber & Mourshed, 2007) speculates that this policy may have further increased the attractiveness of teaching in that country, our colleagues argue that the policy has, in practice, increased the competition at the entry point to the teacher education programs in those universities.

In Canada, admission to an education faculty is reported to be competitive. In Germany, the increasing shortage of future teachers means that almost everyone who wants to enter the profession will get a job (unless he or she has a combination of teaching subjects attracting a large number of applicants, such as German or history). In the United States, teaching candidates who pursue elementary education with licensure in mathematics tend to have lower SAT (Scholastic Aptitude Test) scores than the average college graduate. In Norway, applications for teacher education programs had (as of 2009) been decreasing, and the number of dropouts had risen substantially. As competition for study places lessens, some weak and poorly motivated students have been enrolled, which, in turn, has increased the number of dropouts. This situation seems to confirm claims made in the McKinsey Report that the quality of courses drops as the caliber of students in those courses drops "because the quality of any classroom experience is highly dependent on the quality of people in the classroom" (Barber & Mourshed, 2007, p.18).

Malaysia reported a strengthening demand for teaching from students with higher academic qualifications in recent years because of improved conditions for teachers and a slowdown in the private economic sector. Reports from the Russian Federation, however, indicate that although the status of teaching has been high traditionally, the salary and morale of the teaching profession have weakened in recent years and attrition rates have risen (Burghes, 2008). The report from Georgia points out that entrants to teacher education are rated as low achievers compared to other students in their age cohort.

> Sadly, teaching is one of the least desired professions in Georgia. The still ongoing depreciation of the profession includes decreased salaries as well as decreased social status of teaching. While teaching was one of the most respected professions in the Soviet times, it became less appreciated when teachers appeared to be unprepared for the transition period faced by the country.

Exhibit 2.3 lists the other countries which reported that teaching, as an occupation and as a career option, has low appeal.

2.4.1.3 Admission to teacher education

All participating countries require entrants to *primary school* teacher education programs to have successfully completed secondary education, but few have specific requirements about the level to which entrants should have studied mathematics. Canada, Chile, Georgia, Germany, Malaysia, Norway, the Philippines, Spain, Switzerland, Thailand, and the United States reported no specific mathematics requirement for future primary teachers. The report from the Philippines stated that entrance standards for teacher education are lower than the standards for other degree programs.

Graduation from secondary school with attested proficiency in mathematics is mandated for admission to primary school teacher education in Botswana, Poland, Norway,[4] and Singapore. In Chinese Taipei, students must be enrolled in their second

4 The Norway national research coordinator noted that the requirement in Norway is very low. Applicants need only to have completed Grade 11 general mathematics and be of average proficiency in the subject.

or higher year of university (including Master's and doctoral levels) before they can be admitted to a teacher education program. Although there is no specific secondary school mathematics requirement, students must pass the national university entrance examination, which has mathematics as a required test subject.

In Exhibit 2.4, the TEDS-M countries are categorized according to mathematics requirements for admission to primary teacher education. We emphasize here that graduation from secondary education is a crude measure of academic standards. Graduation in some countries is based on external national examinations, such as the *Matura* in Poland, or subject-based examinations conducted at the school level, such as for the *Abitur* in Germany. In other countries, graduation may depend more on course completion than on attaining a particular academic standard.

*Exhibit 2.4: Selection requirements and methods (primary)**

Requirement and Method	Countries
Graduation from secondary school—no specific mathematics requirement	Canada, Chile, Georgia, Germany, Malaysia, Norway, Philippines, Spain, Switzerland, Thailand, United States
Graduation from secondary school with specific mathematics requirement	Botswana, Poland,** Russian Federation, Singapore
Graduation from secondary school and requirement for one year of tertiary-level studies; national examination to enter university with mathematics as a required subject	Chinese Taipei

Notes:

* Oman was not training primary school teachers at the time of TEDS-M because of oversupply.

** Only for teachers in Poland who will teach Grade 4 and above.

Botswana, Poland, and Singapore appear together in Exhibit 2.4, but we remind readers that generalist primary teachers in Poland are expected to teach Grades 1 to 3 only whereas in Botswana they may teach Grades 1 to 7. Understandably, therefore, expectations about the level of mathematics studied in secondary school vary from country to country. In addition, in some countries, such as Poland, all teachers of Grades 4 and beyond are specialist mathematics teachers and are therefore expected to have a high level of mathematics knowledge and competency.

It is important to note that Exhibit 2.4 does not provide information about the extent to which future primary teachers must study mathematics during their teacher education program. That information can be found in Chapters 4 and 7. But to give an example, Germany (with the exception of a few federal states) requires entrants to the second cycle of professional preparation to have successfully completed mathematics courses during the first cycle of tertiary education.

Standards for entry to programs that prepare teachers who will teach mathematics at the *lower-secondary level* are more difficult to estimate. We might expect that the level to which entrants have previously studied mathematics will be greater for consecutive than for concurrent programs. By definition, entry to consecutive training programs is only open to students who have completed mathematics courses successfully at university. Countries with such programs include Canada, Georgia, Malaysia, Norway, Oman, Singapore, Thailand, and the United States.

However, to blur the picture somewhat, most of these countries also have concurrent programs for preparing secondary mathematics teachers. These programs include mathematics course requirements to varying levels. Also, as explained earlier, the two-phase programs in Germany cannot be classified simply as either concurrent or consecutive. However, the fact that students must pass the first state examination before proceeding to the second implies these programs have more in common with consecutive than concurrent ones.

In Exhibit 2.5, the TEDS-M countries are grouped in accordance with the level to which entrants to lower-secondary teacher education programs need to have studied mathematics at school. Future lower-secondary teachers in Chile, the Philippines, Thailand, and Switzerland are trained mainly in concurrent programs that have no specific requirements about the level to which entrants must have studied mathematics in secondary school. Most future lower-secondary mathematics teachers in Botswana, Chinese Taipei, Georgia, Malaysia, Norway,[5] Oman, the Russian Federation, and the United States are also trained in concurrent programs, but a specified level of achievement in mathematics at the secondary level is required. However, both groups of countries usually require future mathematics teachers to undertake some mathematics courses as part of their university program.

*Exhibit 2.5: Level of mathematices required to enter teacher education programs (lower-secondary)**

Requirements and Methods	Countries
Graduation from secondary school— requirement	Chile, Philippines, Thailand, Switzerland no specific mathematics
Graduation from secondary school with specific mathematics requirement	Botswana, Georgia, Malaysia, Norway (ALU & ALU$^+$), Oman, Poland,** Russian Federation, United States
Graduation from university with a first degree in mathematics or successful completion of designated mathematics courses at university level	Canada, Chinese Taipei, Germany, Norway (PPU & Master's programs), Singapore, Spain

Notes:

* Each country is classified in terms of requirements that apply to most of the future teachers in the TEDS-M sample.

** In Poland, this applies only to programs included in the TEDS-M sampling frame. Successful completion of mathematics courses is a requirement for "second degree studies" in mathematics for secondary school teaching.

The third set of countries has stronger requirements. Teachers at the lower-secondary level are expected to be teachers with specialist training in teaching mathematics (e.g., teaching no more than two or three subjects at that level). In these countries, entrants to programs usually have to complete a university degree in mathematics or complete a number of designated mathematics courses at university level before they can enter the teacher-training phase or, as in the case of Chinese Taipei, students must pass the national university entrance examination, which has mathematics as a required test subject. The countries are Canada, Chinese Taipei, Germany, Norway (PPU and Master's), Singapore, and Spain.[6] Again, even though graduation from secondary education is a rather crude measure of academic standards, it is the selection most commonly cited in the TEDS-M country reports.

For the purposes of the TEDS-M survey, a particular area of interest across the participating countries was whether students at the lower-secondary level (e.g., Year 8) are taught mathematics by teachers trained as generalists or teachers with

5 Norway points out, however, that the standard of mathematics required to enter ALU and ALU plus programs is low.

6 Note, however, that future lower-secondary teachers from Spain did not participate in TEDS-M.

specific training in teaching mathematics. The country reports revealed that teachers in Botswana, Chile, and Norway are mainly trained in generalist program-types. The same might appear to be the case for Germany, Thailand, and the United States, but in these countries, the difference is not clear cut; they have program-types that train specialist mathematics teachers who are eligible to teach across the later primary and early secondary levels.

As indicated, expectations about the levels of mathematics required of future lower-secondary teachers vary with the structure of the school system. If students at the lower-secondary level are part of schools of basic education linked to primary levels (such as in Chile or Norway), their mathematics teachers are more likely to be generalist teachers who teach a range of subjects other than mathematics. Teachers trained to teach no higher than the lower-secondary level are less likely to be expected to have specific training in how to teach mathematics as specialists and are more likely to teach other subjects as well as mathematics.

In Switzerland, lower-secondary schools normally enroll students up to Grade 9, and students are usually taught by generalist teachers who teach about four different subjects. If the students are part of secondary schools that provide preparation up to Grades 12 or 13 (as in Canada, Chinese Taipei, Germany (*Gymnasia* only), Poland, Russian Federation, Singapore, and the United States), they are more likely to be taught mathematics by teachers trained as specialists in mathematics.

In summary, differentiation based on generalized or specialist training is complex, making it difficult to place countries in the respective categories with full confidence. What can be said with some confidence, though, is that students are more likely to be taught mathematics by teachers with specialist training in the teaching of mathematics in Canada, Chinese Taipei, Germany, Malaysia, Oman, Poland, the Russian Federation, and Singapore than are students in the other TEDS-M countries.

2.4.2 Evaluation and Accreditation of Teacher Education Institutions

Accreditation in this report refers to an endorsement by an external agency that a teacher education program is able to produce graduates who are competent to enter the profession and to begin practice. TEDS-M gathered information from each participating country about policies and agencies focused on monitoring and assuring the quality of teacher education institutions and programs.

Some accreditation agencies are part of a national ministry of education, as with the National Agency for Quality Assurance and Accreditation in Spain, the Federal Education and Science Supervision Agency in the Russian Federation, and the Commission on Higher Education (CHED) in the Philippines. Some are part of state governments, as in Germany. Some are set up as independent statutory authorities, such as the Ontario College of Teachers, the California Commission on Teacher Credentialing, the Norwegian Agency for Quality Assurance in Education, and the Office for National Education Standards and Quality Assessment in Thailand. Many of these bodies have a certification or licensing function for beginning teachers as well as an accreditation function. The United States is unique in allowing the establishment of independent, not-for-profit, national professional agencies that provide voluntary accreditation at the national level. One such agency is the National Council for Accreditation of Teacher Education, which accredits about 40% of teacher education programs in the United States.

There is a strong trend within the European community to establish or strengthen accreditation agencies in order to facilitate, in accordance with the Bologna Process (European Commission, 2011), mutual recognition of tertiary qualifications. As a generalization, institutions for training primary teachers have been more regulated in the past than have universities for training future secondary teachers.

Countries vary considerably therefore in terms of the locus of authority for regulating and accrediting teacher education programs and institutions. They also differ in terms of the nature and strength of central regulation and its capacity to shape and assure the quality of teacher education. To capture this variation, the TEDS-M research team classified accreditation systems in countries participating in TEDS-M according to the following typology, which is adapted from the typology used in the Eurydice study (Eurydice, 2006):

1. Countries with weak regulations or that have only voluntary systems for evaluating and accrediting teacher education programs;
2. Countries with general regulations for evaluation of all higher education institutions, but no regulations specific to teacher education institutions or programs;
3. Countries with specific as well as general regulations, but only for internal evaluations by institutions—no requirement for external evaluations;
4. Countries that require teacher education institutions or programs to be evaluated by an independent, external accreditation authority or agency, which have the power to disaccredit.

Exhibit 2.6 shows the countries participating in the TEDS-M study classified, according to this typology, on the basis of information provided in the country reports and the Eurydice study. The exhibit details arrangements mainly for primary teacher education programs; there is, however, considerable overlap in quality assurance arrangements for primary and secondary teacher education.

Exhibit 2.6: Accreditation systems for teacher education, 2008

Regulation of Teacher Education	Countries
Category 1: Countries with unregulated teacher education systems or voluntary accreditation only	Chile, Philippines, Georgia, Oman
Category 2: Countries with agencies responsible for the accreditation of higher education institutions, but that have limited requirements with respect to evaluating specific teacher education programs	Germany, Spain, Switzerland
Category 3: Countries with agencies responsible for the accreditation of teacher education institutions, but based mainly on internal evaluations conducted by institutions; no independent, external evaluation	Malaysia, Norway, Poland
Category 4: Countries with external evaluation and accreditation of teacher education providers by a government, statutory, or professional agency. Power to disaccredit programs	Botswana, Canada, Chinese Taipei, Russian Federation, Thailand, United States
Special case:	Singapore

Although all NRCs carefully checked Exhibit 2.6, caution is needed when interpreting its contents. As a generalization, the strength of the regulatory system increases from Category 1 to 4. However, the mere presence of an accreditation system is not necessarily a clear indication that teacher education standards are high, or the reverse. Some countries have national teacher education accreditation bodies, but these bodies lack the authority to evaluate programs rigorously or to revoke accreditation for poorly performing programs. Although Botswana, Chinese Taipei, the Russian Federation, Thailand, and the United States are alike in having agencies for the accreditation of teacher education, it is clear from the country reports that these agencies differ in their capacity to evaluate teacher education programs and assure their quality.

In Chinese Taipei, the Teacher Education Certification Committee exercises a strong influence over providers. Since 2005, it has adjusted the admission quota of future teachers according to yearly evaluations. Accreditation methods are based primarily on field visitations. Over the past three years, six teacher education universities received Level-3 ratings and were disqualified from providing teacher education programs.

Singapore is a special case because there is only one teacher education provider. It does not have an independent external accreditation body. However, on close inspection, it is evident that quality assurance mechanisms for teacher education are strong in that country. There are close links between the National Institute of Education and the Ministry of Education, and strong feedback systems are in place regarding program quality. In addition, international experts are regularly employed to provide independent evaluations in specialist fields such as mathematics teacher education.

In Germany, specific regulations apply solely to the evaluation of the second, "on-the-job" qualifying phase, which is organized by special second-phase institutions (*Studienseminare*) in each federal state. External evaluations are not compulsory. The management of universities or teacher education colleges—or the minister of education in the case of the second-phase institutions—are entitled to request an external evaluation if they consider this to be necessary in light of internal evaluation results.

In the Russian Federation, the Federal Education and Science Supervision Agency carries out state-education quality control in educational institutions both independently and with regulatory bodies of education of the constituent entities of the Russian Federation. It also carries out licensing, certification, and state accreditation of educational institutions and their branches as well as of scientific organizations (in the sphere of continuing vocational education and post-graduate education).

Few countries have subject-specific standards for accrediting programs. Chile is moving in this direction for its primary teacher education programs. It is developing detailed guidelines on the mathematical and pedagogical knowledge that it expects future primary teachers to learn. It is doing the same for other subjects, such as science and social studies. Some states in the United States have been moving in this direction as well. The National Council for Accreditation of Teacher Education uses subject-specific standards for accrediting programs, although its system is voluntary. It is also moving from input- to outcome-based accreditation.

2.4.3 Requirements for Entry to the Teaching Profession

Gaining entry to the profession is arguably the critical decision point in assuring teacher quality. In TEDS-M, data were gathered about policies and agencies that participating countries had in place to ensure that graduates are competent and qualified to gain certification and full entry to the profession. In the TEDS-M study, the term *certification* is used to mean the same as registration or licensing, that is, an endorsement that a person has attained the standards for full entry to the teaching profession. This endorsement may be given by a government agency, a statutory authority, or, in rare cases in teaching, a professional body. The certification body is often the same agency that is responsible for accrediting teacher education programs. An example is the Ontario College of Teachers.

Quality assurance policies and practices relating to entry to the profession vary widely across the TEDS-M participating countries. In 2008, requirements for entry to the profession in participating countries fell into the following three main categories, as shown in Exhibit 2.7:

- *Category 1* countries, where graduation leads automatically to certification and/or official entry to the teaching profession;
- *Category 2* countries, where entry to the profession depends on passing further tests set by external agencies (e.g., licensure tests of professional knowledge);
- *Category 3* countries, where entry to the profession depends on passing further tests of professional knowledge and assessments of teaching performance during a probationary period.

Exhibit 2.7: Entry to the teaching profession, 2008

Entry to the Teaching Profession/Certification	Countries
Category 1: Countries where graduation leads automatically to official entry to the teaching profession	Botswana, Chile, Georgia, Malaysia, Norway, Poland, Russian Federation, Singapore, Spain,* Switzerland, Thailand
Category 2: Countries where entry to the profession depends on passing further tests set by external agencies (e.g., licensure tests of professional knowledge)	Canada (Ontario), Oman, Philippines, Spain**
Category 3: Countries where entry to the profession or gaining employment depends on passing further tests of professional knowledge and assessments of performance	Chinese Taipei, Germany, United States

Notes:

* Spain: private school teachers.

** Spain: public school teachers.

Most TEDS-M countries are in Category 1, which means that those students who have met the graduation requirements of their training institution are deemed also to have met the requirements for full entry to the teaching profession. Other countries have several filters at this stage, including external examinations (e.g., of subject-matter knowledge), a probationary period in a school, and an assessment of performance before a graduate teacher can gain official entry to the profession. These filters are indicative of an increasing trend to distinguish the requirements for graduation from a university or college from the requirements to gain official entry to the profession (i.e., receive certification).

Responsibility for the latter is being placed increasingly in the hands of government agencies or statutory professional standards boards. Examples include the Ontario College of Teachers, the Teacher Professional Development Center in Georgia, and the Teachers Council of Thailand. In part, this practice is an acknowledgment that making an accurate prediction about a teacher's competency is difficult until he or she has worked in schools for a period of time and experienced authentic teaching responsibilities. This trend is leading to increasing interest in effective mentoring and induction programs and in more valid ways to assess teacher performance against professional standards.

In Spain, graduation for future primary teachers is sufficient to become a teacher in a private school. However, teachers who want to be civil service teachers and teach in a state school must pass a further competitive test which has a fixed quota limiting the number of passes. In several TEDS-M countries, the agency responsible for official entry or certification is essentially the national or state government. This is the case in career-based systems, for example, where teachers gain access to the civil service through a state examination after graduating from a university teacher education program. In Singapore, the responsible agency is the Ministry of Education. In such cases, the government is the body that regulates the teaching profession.

Countries in Category 2 generally require graduates to take an external entry test, in addition to gaining a university qualification, to assure the quality of new teachers. The responsible body is usually a state or a national government.

In Category 3, countries such as the United States use a process of certification or licensing, whereby most states assess the qualifications of individuals to teach. However, a few states delegate this function to a state professional standards body. In the Philippines, the responsible body is the Professional Regulation Commission, the agency that grants licenses to practice in all professions. In Chinese Taipei, entry is a two-stage process. Graduates must pass a national test, the Teacher Qualification Assessment, to be officially qualified by the Ministry of Education. However, gaining a position in a school depends on another "screening" process that operates at the local level. This involves more written tests, and assessments of teaching performance as well.

2.4.4 Summary of Quality Assurance Policies in TEDS-M Countries

The purpose of the fourth part of this chapter (Section 2.4) has been to summarize policies for assuring the quality of initial teacher education. This information allows exploration of relationships between these policies and measures of teacher education practices and outcomes developed in the TEDS-M study and reported in later chapters of this report. Among the many questions that can be asked are the following:

- What is the relationship between the mathematical knowledge of future teachers and the relative strength of national quality assurance systems?
- Are opportunities to learn mathematics during teacher education programs greater in countries with strong quality assurance systems than in countries without?
- Do future teachers from countries with strong controls over standards for *entry* to teacher education programs have more knowledge of mathematics than future teachers from countries that focus on standards for the accreditation of programs?
- Is there less variation in future teachers' perceptions of the quality of their training and their preparedness to teach in countries that have rigorous and compulsory accreditation systems?

Many similar questions can be explored.

So that they could explore such questions, the TEDS-M research team had to find a defensible way to assess the relative strength of quality assurance systems. Exhibit 2.8 brings together the findings about quality assurance arrangements presented earlier in Exhibits 2.2 to 2.7. These arrangements include policies designed to assure:

- The quality of entrants to teacher education;
- The quality of teacher education programs; and
- The quality of the qualifications that graduates of teacher education programs must have in order to enter the profession.

In Exhibit 2.8, the depth of shading indicates the strength of quality assurance arrangements. Darker shading indicates stronger quality assurance. More detail on estimating the relative strength of quality assurance arrangements can be found in Ingvarson et al. (forthcoming).

Exhibit 2.8: Quality assurance mechanisms in teacher education

Country	Entry into Teacher Education			Accreditation of Teacher Education Programs	Entry to the Teaching Profession	Relative Strength of Quality Assurance System
	Control over supply of teacher education students	*Promotion of teaching as an attractive career*	*Selection standards for entry to teacher education*			
Botswana						Moderate
Canada						Moderate
Chile						Low
Chinese Taipei						High
Georgia						Low
Germany						Moderate/High
Malaysia						Moderate
Norway						Moderate/Low
Oman (Secondary)						Low
Philippines						Low
Poland						Moderate
Russian Federation						Moderate
Singapore						High
Spain						Moderate/Low
Switzerland						Moderate
Thailand						Low
United States						Moderate

Key: Strong quality assurance procedures — Moderately strong quality assurance procedures — Limited quality assurance procedures

To illustrate, using Botswana as the example, we can see from Exhibit 2.8 that Botswana reported relatively strong controls over supply and demand and entry to teacher education for primary teachers; however, the Botswana NRC reported concerns about the country's ability to attract stronger students into mathematics teacher education programs. The exhibit also shows that Botswana has specific mathematics requirements for entry to teacher education and moderately strong arrangements for evaluating and accrediting teacher education programs. And although Botswana has a probationary period for beginning teachers, there are no formal requirements for graduates to be assessed before gaining entry to the profession. Overall, Botswana has stronger arrangements for quality assurance than some countries and weaker arrangements than others. Its quality assurance arrangements are therefore rated as medium strength in relation to other countries that participated in TEDS-M.

Exhibit 2.8 furthermore shows that, of the 17 countries participating in TEDS-M, Chinese Taipei and Singapore have the strongest and most coordinated quality assurance systems. They have relatively strong policy arrangements in place to assure the quality of future teachers. There are quotas on the number of teacher education places. Policies developed over many years ensure that teaching is a relatively attractive career option for abler students. Selection standards are high. A rigorous system for external evaluation of teacher education programs is in place and, in the case of Chinese Taipei, entry to the profession does not follow automatically on graduation from a teacher education program. In addition, full entry to the profession depends on an additional assessment of professional knowledge, while securing a teaching position depends on a satisfactory assessment of performance capabilities after a probationary period in schools.

Five countries in TEDS-M reported having strong controls over the number of entrants accepted into teacher education programs: Botswana, Chinese Taipei, Malaysia, Oman, and Singapore (see Exhibit 5.8). Canada, Chinese Taipei, and Singapore have specific policies to ensure that teaching is an attractive career and recruits are able high school graduates. Chinese Taipei and Singapore have the highest requirements for the mathematics courses that future teachers must complete in order to enter the professional training component of their teacher education program.

Another finding of note in Exhibit 2.8 is that rigorous procedures for assessing and accrediting teacher education programs are rare in the TEDS-M countries, a situation that contrasts with many other professions, such as engineering and accountancy, which are using outcome measures and moving to international approaches that provide mutual recognition of accreditation procedures and qualifications. Singapore and Chinese Taipei have the strongest arrangements for monitoring and evaluating the effectiveness of their teacher education programs in terms of outcomes.

We can also see from Exhibit 2.8 that graduation from teacher education programs in most TEDS-M countries leads automatically to full entry to the profession. In the Province of Ontario, new teachers must complete a probationary year of successful teaching before being able to apply for full registration, signed off by the superintendent of the local school board. The Ontario report gave no details on the rigor and consistency of the methods used to assess success.

The United States has rigorous procedures for assessing beginning teacher performance in some states, but the procedures are applied inconsistently across institutions and programs. Some states also allow for alternative routes into teaching and even "emergency" certification of teachers in areas where there are shortages. Chinese Taipei enforces its quality control over entrants more consistently than do the other TEDS-M countries. Germany sits in this group because future teachers in the second phase of training spend the equivalent of at least 1.5 to 2 years in schools, taking full responsibility for a class and participating in other school-based tasks. They work with mentor teachers, and their performance must be assessed as part of the second state examination.

Ingvarson et al. (forthcoming) explore in more detail the relationships between the strength of quality assurance arrangements and the mathematical knowledge of future teachers. The analysis of data conducted for that report indicates that, based on the TEDS-M countries as units of analysis, there is a relationship between quality assurance arrangements and the mathematics knowledge of future primary generalist teachers. There is also a relationship between quality assurance arrangements and the mathematics knowledge of future lower-secondary teachers and future upper-secondary teachers.

Countries with strong quality assurance arrangements, such as Chinese Taipei and Singapore, scored highest on the outcome measures used in the TEDS-M survey. Countries with weaker arrangements, such as Georgia and Chile, tended to score lower on measures of mathematics content knowledge (MCK) and mathematics pedagogy content knowledge (MPCK).

2.5 Conclusion

In this chapter, we summarized information about teacher education policies and working conditions for teachers in the TEDS-M countries. These two factors may be relevant to understanding the processes and outcomes of teacher education and the attractiveness of teaching as a career.

The ways in which countries organize their teacher education systems reflect a number of policy choices. The length of teacher education program-types is an obvious example, and it is one that has major implications for costs. Whether program-types are concurrent or consecutive, or whether teachers of mathematics have been trained as generalists or specialists are others. Exhibit 2.1 provided a comprehensive summary of the organizational characteristics of teacher education program-types included in TEDS-M. We explore the extent to which variation in these characteristics leads to differences in opportunities to learn mathematics content and mathematics pedagogy and other outcomes in each of the participating countries in later chapters of this report, as well as in other publications from the TEDS-M project.

Determining differences in the positions and careers for which teachers are being prepared is an initial step toward understanding what these positions and careers call for in terms of knowledge for teaching and the nature of the opportunities that future teachers have to learn this knowledge. These again are issues explored in later chapters of this report. This section of the current chapter also detailed the challenges, rewards, and difficulties associated with these positions and careers. From the information provided in the country reports, it is apparent that some TEDS-M countries have established very favorable conditions for teachers while others have not, and still others have much internal diversity in this respect. This variation in employment conditions is determined by many factors, some of which are directly subject to policy change while others are not (e.g., resources available to finance schooling and teacher education).

The last section of the chapter, on quality assurance, concentrated on policies that are more directly under the control of educational policymakers and which could be expected to influence the quality of teacher education. The main finding was the great variation in policies related to quality assurance: in particular, the quality of entrants to teacher education programs, the quality of teacher education programs, and the quality of graduates who gain full entry to the teaching profession.

The TEDS-M data reveal a substantial relationship between the strength of these quality assurance arrangements and the quality of graduates as measured by tests used in the TEDS-M study (as reported later in this volume). Countries with strong quality assurance arrangements, such as Chinese Taipei and Singapore, scored highest on the outcome measures used in TEDS-M; countries with weak arrangements scored lowest.

Chinese Taipei and Singapore do very well on international tests of student achievement, such as TIMSS (Mullis, Martin, Olson, Berger, Milne, & Stanco, 2007). These are the same countries that not only ensure the quality of entrants to teacher education, but also have strong systems for reviewing, assessing, and accrediting teacher education providers. They have also developed strong mechanisms for ensuring that graduates meet high standards of performance before gaining certification and full entry to the profession. These country-level relationships between quality assurance policies and student achievement call for further investigation.

References

Barber, M., & Mourshed, M. (2007). *How the best performing school systems come out on top*. London, UK: McKinsey & Co.

Burghes, D. (2008). *International Comparative Study in Mathematics Teacher Training* (CfBT). University of Plymouth, UK: Education Trust.

European Commission. (2011). *The Bologna Process: Towards the European Higher Education Area*. Brussels, Belgium: Author. Retrieved from http://ec.europa.eu/education/higher-education/doc1290_en.htm

Eurydice (2006). *Quality assurance in teacher education in Europe*. Brussels, Belgium: European Commission.

Hanushek, E. A. (2004). *Some simple analytics of school quality* (Working Paper No. 10229). Cambridge, MA: National Bureau of Economic Research.

Hattie, J. (2008). *Visible learning: A synthesis of over 800 meta-analyses relating to achievement*. London, UK: Routledge

Ingvarson, L. C., Schwille, J., Tatto, T., Rowley, G., Senk, S., & Peck, R. (forthcoming). *National policies and regulatory arrangements for the preparation of teachers in TEDS-M countries*. Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement.

Organisation for Economic Co-operation and Development (OECD). (2005). *Teachers matter: Attracting, developing and retaining effective teachers*. Paris, France: Author.

Mullis, I. V. S., Martin, M. O., Olson, J. F., Berger, D. F., Milne, D., & Stanco, G. M. (Eds.). (2008). *TIMSS 2007 encyclopedia: A guide to mathematics and science education around the world* (Vols. 1 & 2). Chestnut Hill, MA: Boston College.

Schwille, J., & Dembélé, M. (2007). *Global perspectives on teacher learning: Improving policy and practice* (Fundamentals of Educational Planning, No. 84). Paris, France: International Institute for Educational Planning, UNESCO.

Schwille, J., Ingvarson, L., & Holdgreve-Resendez (Eds.). (forthcoming). *TEDS-M encyclopedia: A guide to teacher education context, structure and quality assurance in the seventeen TEDS-M countries*. East Lansing, MI: TEDS-M International Study Center.

Tatto, M. T. (2007). *Reforming teaching globally*. Oxford, UK: Symposium Books (reissued in 2009 by Information Age Publishers).

CHAPTER 3:

THE DISTINCTIVE NATIONAL IMPRINT OF EACH TEDS-M SYSTEM

3.1 Chapter Overview

Although there are many commonalities across national systems of teacher education, at least in terms of the organizational characteristics by which they were analyzed in Chapter 1, each has its own particular characteristics. This national imprint is rooted in history and reflects a particular cultural, social, and political context. We begin this chapter with a comparison of the 17 countries in terms of relevant demographic and development indicators, and then provide a brief summary of the salient, distinctive organizational features of all 17 of the teacher education systems represented in TEDS-M. What becomes apparent as this chapter unfolds is that the countries and their teacher education systems parallel one another in various respects, but they also all differ from one another in distinctive, non-parallel ways that need to be taken into account when interpreting the TEDS-M survey data. Each country summary is based primarily on the TEDS-M country reports, with authorship as cited in each section.

3.2 National Differences in Demographic and Development Indicators

The 17 countries that agreed to participate in TEDS-M differ in many important geographic, demographic, economic, and educational respects. A selection of these characteristics is presented in Exhibits 3.1 and 3.2. The TEDS-M sample included very large countries, such as the Russian Federation and the United States, and small countries such as Singapore. Although well over half the population lives in urban areas in nearly all of the countries, some countries are densely populated while others are sparsely populated (just 3 people per square kilometer in Botswana, compared with 230 in Germany, 301 in the Philippines, and 6,545 in the city-state of Singapore). It is more challenging for education systems, in general, and teacher education, in particular, to serve a widely dispersed population. Health statistics are also relevant. A high incidence of poor health affects all sectors of society, including education, and the effect is especially great in the case of pandemics such as HIV/AIDS. TEDS-M countries are relatively fortunate in this respect: as shown in Exhibit 3.1, life expectancy at birth is high in the TEDS-M countries. It is, on average, above 70 in all but three countries (80 or more in six). These healthy, aging populations will, all else being equal, make for slower growth in the demand for basic education.

The TEDS-M countries vary greatly with respect to per capita income. Countries with very large per capita incomes can more readily fund the needs of education than those where resources are far more limited. A look at gross national income (GNI) per capita (all amounts are shown in US dollars) reveals roughly four levels of wealth across the TEDS-M countries (the last column of Exhibit 3.1). Countries that score *very high* on this index (with a range of $40,000 to just above $60,000) are (in descending order) Norway, Singapore, the United States, and Switzerland. The next set of countries, labeled *high* (a range of $30,000 to $40,000), are Canada, Germany, Chinese Taipei, and Spain. The set of countries labeled *middle* (with a range of $10,000 to $30,000) include Oman, Poland, the Russian Federation, Malaysia, Chile, and Botswana.

Exhibit 3.1: TEDS-M participating countries: national demographic and human development statistics

Country	Population (millions)	Area (1,000s of sq km)	Population Density (people per sq km)	Urban Population (% of total)	Life Expectancy at Birth (years)	Rank in Total GDP	GNI per Capita (Purchasing Power Parity)	Levels of Wealth
Botswana	1.9	582	3	59	54	113	13,250	Middle
Canada	33.3	9,985	3	80	81	10	38,490	High
Chile	16.8	756	22	88	79	45	13,430	Middle
Chinese Taipei	22.9	36	637	80	78	20	32,700	(High)
Georgia	4.3	70	62	53	72	117	4,860	Low
Germany	82.3	357	230	74	80	4	37,510	High
Malaysia	27.0	331	82	70	74	40	13,900	Middle
Norway	4.8	324	12	77	81	23	60,510	Very high
Oman	2.8	310	9	72	76	74	24,530	Middle
Philippines	90.3	300	301	64	72	47	3,940	Low
Poland	38.1	313	122	61	76	21	17,640	Middle
Russian Federation	141.4	17,098	8	73	68	12	19,770	Middle
Singapore	4.6	1	6,545	100	81	43	52,000	Very high
Spain	44.5	506	88	77	81	9	32,060	High
Switzerland	7.5	41	183	73	82	19	42,220	Very high
Thailand	67.4	513	131	33	69	32	7,830	Low
United States	311.7	9,629	32	81	78	1	47,100	Very high

Notes:
1. GDP = gross domestic product, GNI = gross national income.
2. For the sources of these statistics, see Exhibit A3.1 in Appendix A.

Exhibit 3.2: TEDS-M participating countries: youth demographic and education statistics

Country	Total Fertility Rate	Population Age Composition Ages 0–14 (%)	Public Expenditure on Education (% of GDP)	Net Enrollment Ratio in Education (% of relevant group)		Primary Student–Teacher Ratio
				Primary	*Secondary*	
Botswana	3	34	8.1	90	64	25
Canada	2	17	4.9	100	94	17
Chile	2	23	3.4	95	85	25
Chinese Taipei	1	17	4.2	97	95	17
Georgia	2	17	2.7	99	81	9
Germany	1	14	4.4	100	89	13
Malaysia	3	30	4.5	96	68	15
Norway	2	19	6.7	99	96	11
Oman	3	32	4.0	72	78	12
Philippines	3	34	2.6	92	61	34
Poland	1	15	4.9	96	94	11
Russian Federation	1	15	3.9	91	–	17
Singapore	1	17	2.8	–	–	19
Spain	1	15	4.4	100	95	12
Switzerland	1	16	5.3	99	85	13
Thailand	2	22	4.9	89	72	16
United States	2	20	5.5	93	88	14

Note: For sources of these statistics, see Exhibit A3.2 in Appendix A.

The final set of countries—those with the lowest GNI in the TEDS-M study and therefore labeled *low* (with a range of $3,000 to $10,000)—are Thailand, Georgia, and the Philippines. There were no very low income countries in the sample, that is, those countries with GNI per capita of less than $3,000.

TEDS-M also included some of the largest economies in the world, as measured by total gross domestic product (GDP) for 2008. The United States (ranked first), Germany (fourth), Spain (ninth), Canada (10th), and Russia (12th) are all among the most highly ranked of 186 countries with economies of more than US$1 trillion each in total GDP. Nine others are also in the first quartile of countries, when ranked by the total size of their economy, even though some of these countries are very small in terms of population: Switzerland (19th), Chinese Taipei (20th), Poland (21st), Norway (23rd), Thailand (32nd), Malaysia (40th), Singapore (43rd), Chile (45th), and the Philippines (47th). Thus, only one country (Oman) is in the second quartile, and the two remaining countries (Botswana and Georgia) are just slightly below the median rank. TEDS-M makes no claim to being representative of the world's countries. It includes instead a relatively advantaged, but still diverse, subsample.

The factors affecting population growth—fertility, mortality, and net immigration—also differ greatly among the TEDS-M countries. A higher rate of population growth means a greater need for schools and teachers, which, in turn, affects the demand for teacher education. Conversely, and without compensating for rates of immigration, if there is a decline in the number of children born because of declining fertility rates, the need for new teachers will decline, thus reducing the demand for teacher education. When we look at the total fertility rates of TEDS-M countries, we see that, in general, this is a group of low-fertility countries. According to recent statistics (shown in Exhibit 3.2), all but four of the TEDS-M countries are at or below the replacement level (which ranges from about 2.1 to 2.3 children born per woman, depending on adjustments made for mortality and sex ratios at birth). The four countries with high total fertility rates are Botswana, Malaysia, Oman, and the Philippines. A closely related statistic, the percentage of the total population aged birth to 14 years, shows the same four countries at a relatively high level; about a third of their respective populations comprise this young age group. All the other countries with lower total fertility rates have a much smaller proportion of children in the total population, from 14 to 23%. Even with equal levels of per capita wealth, countries with a lower proportion of children find it easier to support teachers and teacher education.

In another demonstration of important country differences, Exhibit 3.2 provides key statistics on education, including public expenditure on education, net enrollment ratios in primary and secondary schools, and student–teacher ratios. Most revealing among these data is public expenditure on education, as indicated by percentage of GDP. The countries that allocate the highest proportion of their GDP to public education are Botswana and Norway (8.1 and 6.7%, respectively). These are followed by five countries at about 5.0 to 5.5% (United States, Switzerland, Poland, Thailand, and Canada), then six countries at about 4.0 to 4.5% (Malaysia, Germany, Spain, Chinese Taipei, Oman, and Russia), and, finally, four countries at about 2.5 to 3.5% (Singapore, Georgia, the Philippines, and Chile).

Nevertheless, whatever the differences in resources, other education indicators tend toward uniformity. Only Oman is below 89% with regard to primary school enrollment rate and, with the exception of Botswana, Chile, and the Philippines, student–teacher ratios in primary schools are in the 10 to 20 students per teacher range or even slightly lower. Secondary enrollment rates, however, show more variation. The move toward a universal basic education, with 8, 9, or 10 years of compulsory schooling, is still far from complete, even among the TEDS-M countries.

Within these varied and changing contexts, teacher education has been a work in progress for the last 200 years (see the historical chapter in the companion TEDS-M policy volume in Ingvarson, Schwille, Tatto, Rowley, Peck, & Senk, forthcoming), and there is little sign that this situation will change. Systems are in a constant state of flux, making it difficult to describe each system as an ongoing entity. At any one time, a system may be experiencing changing types of program, growth or decline in size, program-types being phased out or created, and discussions of all sorts of other changes that may or may not happen. Thus, both a broader and deeper perspective is needed to make this ongoing mixture of new and old forms of organization, in varying degrees of implementation, and subject to normal fluctuations of growth and decline, more understandable. To this end, TEDS-M country reports provide fascinating windows into how much teacher education systems have come to vary within the context of the continuing effort to make primary and lower-secondary education universal throughout the world. In this process, each of the program-types described below has come to have its own distinctive character in response to these different contexts.

3.2 Country-by-Country Introduction to Program-Types and Their National Contexts

The remainder of this chapter portrays the distinctive characteristics and context of each national system, in terms of what the authors of the country reports consider is most important for readers to know when analyzing and interpreting the TEDS-M survey data. In addition to a narrative explanation, each section contains three graphs that give an immediate visual image of the diversity of program-types within and across countries. These graphs are based on Exhibit 2.1 and on a table displaying estimated sizes of program-types as an additional feature.

The three organizational characteristics portrayed in these graphs were discussed in cross-national terms in Chapter 2. They are:

- The grade span for which each country prepares teachers;
- The duration of each program-type (i.e., the total number of years of post-secondary education required to become a fully qualified teacher); and
- The size of the program-type in terms of number of future teachers (FTs) in the final year of their teacher education (as estimated from the TEDS-M sample).

The narrative summarizes the distinctive national context required for understanding these program-types and for interpreting the data discussed in later chapters. These are listed under three headings: (1) institutions and governance, (2) program-types and credentials, and (3) curriculum content, assessment, and organization.

3.2.1 Botswana[1]

Botswana is a classic mixed system, in which some teachers are prepared at the university, while others are enrolled in teachers' colleges that do not have university status.

3.2.1.1 Institutions and governance

Under its Ministry of Education, Botswana has six colleges of education; four prepare only primary school teachers and two prepare only secondary school teachers. Primary and secondary teachers are also trained at what was, until recently, the country's only university, the University of Botswana. It has more autonomy than the colleges (e.g., to set limits on admissions).

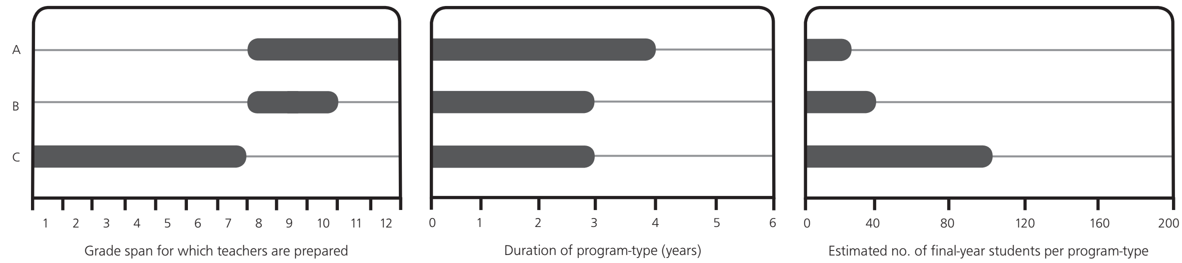
3.2.1.2 Program-types and credentials

Primary school in Botswana extends from Grades 1 to 7—longer than in most countries. Junior secondary schools cover Grades 8 to 10; only 56% of the age group's population is enrolled in secondary education, a proportion that is lower than in any other TEDS-M country. Teacher education aligns with these school types (see Exhibit 3.3). The Botswana authors reported one primary program-type—the Diploma in Primary Education from the colleges, as portrayed in Exhibit 3.3. (The Bachelor of Primary Education from the university was not included in TEDS-M due to a lack of students.) Secondary teachers can be prepared in four program-types: one at the two colleges for teachers and three at the university. However, as evident in Exhibit 3.3, only two were included in TEDS-M: the Diploma in Secondary Education at the colleges and the Bachelor of Secondary Education (Science) at the university.

1 This section is based on the national report written by K. G. Garegae, T. J. Mzwinila, and T. M. Keitumetse.

The latter is a concurrent program-type with more demanding entrance requirements than the corresponding program-type at the colleges. Graduates of this program-type can teach up to Grade 12, whereas the graduates of the college program-type can teach only up to Grade 10. The two secondary program-types not included in the TEDS-M target population are the consecutive Post-Graduate Diploma in Education, which produces almost no graduates, and the B.Ed. (secondary) program-type, which is intended for practicing teachers who have at least two years' teaching experience.

Exhibit 3.3: 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.

3.2.1.3 Curriculum content, assessment, and organization

The colleges offer a three-year, full-time program-type. The first year, for example, includes courses in communication and study skills, educational technology, special needs education, two teaching subjects, and teaching practice. Although primary teachers are expected to teach all subjects, a new trend is to add a specialization in certain areas, such as primary education and mathematics/science. At the university, the Bachelor of Secondary Education (Science) produces teachers of mathematics as well as science. It is a full-time, four-year program-type, but students start taking education coursework only in the second year. Overall, this program-type is 70% content and 30% mathematics education. The instructor determines course content, and submits a course outline to the department head for his or her approval.

Each program-type has different practicum requirements. The colleges of education require two weeks of classroom observation in the first year (for primary but not secondary future teachers), 10 weeks of internship in Year 2, and a five-week practicum in Year 3. At the university, the Bachelor of Secondary Education (Science) students undertake seven weeks of teaching practice during both Years 2 and 3.

College students are required to complete written assignments, annual examinations, and a final research project. An external moderator conducts a final assessment of every student's work. This includes a research project and teaching practice. At the university, the final grade for each course combines continuous assessment and a final examination. Teaching practice is graded pass or fail; there is no external moderation.

3.2.2 Canada (Newfoundland and Labrador, Nova Scotia, Québec, and Ontario)[2]

In Canada, education is the responsibility of each province or territory; there is no federal body overseeing education at the national level. TEDS-M was conducted in four Canadian jurisdictions—Newfoundland and Labrador, Nova Scotia, Ontario, and Québec. These four provinces account for 66% of the total Canadian population, estimated at nearly 34 million in 2010 (62% of all Canadian residents live in Ontario and Québec).

3.2.2.1 Institutions and governance

Teacher education is offered in a total of 56 institutions across all provinces in Canada. A small number of these are affiliates of larger institutions and include English- and French-speaking programs within the same institution. Multiple institutions are found in all but two provinces, Newfoundland and Labrador, and Prince Edward Island. Four institutions in Nova Scotia offer teacher education, three in English and one in French. Twelve institutions offer teacher education in Québec—nine in French and three in English. There are 13 faculties of education in Ontario universities. All 13 have offerings in English and two also in French. There is no preservice teacher education in Canada's three territories, as they tend to draw their teachers from the provincial teacher education institutions across the country.

3.2.2.2 Program-types and credentials

Canada has diverse program-types but they share commonalities. In general, teacher education institutions offer two routes to graduation—concurrent or consecutive. Concurrent program-types usually offer four years of professional education courses along with academic courses. Some of these concurrent program-types lead to a Bachelor of Education (B.Ed.) degree; others, which require five years, lead to a degree in an academic specialty, as well as the B.Ed. Consecutive program-types require candidates to obtain an academic degree before being accepted in a teacher education program-type, with the latter usually concentrated into one or two years. The duration is related to certification requirements. For example, the minimum requirement for certification in Nova Scotia is a two-year program-type following the first degree; in Ontario, certification follows a one-year post-degree program-type. The general trend across most provinces is toward consecutive program-types. The exception is Québec, where almost all preservice teacher education is concurrent.

Most institutions offer primary- and secondary-level intakes for each of the two routes to the B.Ed. Primary teachers are usually considered generalists, but teachers at the secondary level are expected to specialize in one or more disciplines. Generally, secondary teachers are expected to specialize in school subjects, that is, subjects mentioned in certification requirements and provincial curricula, and taught in schools. Most primary program-types are concurrent, while secondary program-types are consecutive.

In some jurisdictions, teaching certificates are endorsed only for specific levels or subjects. However, the degree to which teachers holding these endorsed certificates are restricted to their defined areas of specialization varies with jurisdiction and location, and depends on teacher supply and demand.

2 This section was written with the assistance of national research coordinator Pierre Brochu.

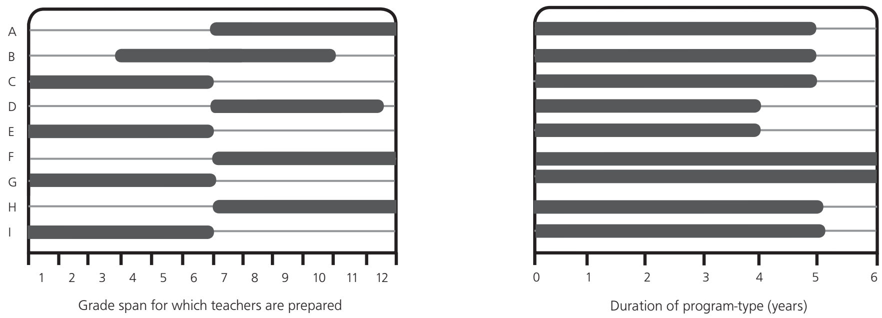
All teacher education program-types in Canada require future teachers to participate in some in-school teaching experience, referred to variously as a practicum, an internship, or student teaching. The long-term trend is toward longer in-school placements, distributed throughout the program-type, rather than concentrated at the end.

Because education is a provincial responsibility, curriculum content, assessment, and certification requirements vary from jurisdiction to jurisdiction (see Exhibit 3.4):

- *Newfoundland and Labrador:* The main program-type divisions are referred to as primary/elementary and intermediate/secondary. The primary/elementary program-type is concurrent, requiring a total of five years to complete. Students typically enter the professional component in their third year. The secondary program-type is a three-semester consecutive one, completed over 14 months. A representative body of stakeholders governs teacher certification in Newfoundland and Labrador, and the Department of Education administers the system.
- *Nova Scotia:* Nova Scotia has the only system in Canada in which a two-year (four-semester) consecutive program-type is the norm and is a requirement for certification. Teacher certification in Nova Scotia is administered by the Department of Education. It is offered at two levels—one for Grades 1 to 6 and the other for Grades 7 to 12.
- *Québec:* Given the concurrent nature of almost all Québec preservice program-types, future teachers in that system generally take four years to complete the B.Ed. degree. Teacher certification in Québec is governed by the *Comité d'agrément des programmes de formation à l'enseignement* (CAPFE), a representative body of stakeholders. Certification is for Grade spans 1 to 6 and 7 to 11.
- *Ontario:* Almost all Ontario institutions offer consecutive program-types (of two semesters' duration) to students who already have a Bachelor's degree. The practicum takes up almost half of that time. Three program-types—primary[3]/junior (Grades K to 6), junior/intermediate (Grades 4 to 10), and intermediate/secondary (Grades 7 to 12)—are typical. This structure conforms to the structure for teacher certification, thereby allowing teachers to be certified to teach across a range of grade levels. Teacher certification in Ontario is governed by the Ontario College of Teachers, an independent body.

3 Note that the term primary as used in Ontario differs from its more general use in TEDS-M. In TEDS-M, *primary* is used consistently for what is generally the first level of compulsory schooling, even when the national terminology is different (e.g., *elementary*).

Exhibit 3.4: Teacher education program-types in Canada



Key to program-type

A—Intermediate/Senior (Ontario)
B—Junior/Intermediate (Ontario)
C—Primary Junior (Ontario)
D—Secondary 1–5 (Québec)
E—Primary (Québec)
F—Secondary (Junior and Senior High) (Nova Scotia)
G—Primary (Nova Scotia)
H—Intermediate/Secondary (Newfoundland-Labrador)
I—Primary/Elementary (Newfoundland-Labrador)

Note: The third graph was omitted because the nature of the data collected meant it was not possible to accurately estimate enrollments by program-type.

3.2.3 Chile[4]

Most teacher education provision in Chile focuses on preparing generalist teachers for all subjects of the eight-year basic school. In this respect, Chile differs from most countries, where teachers for Grades 7 and 8 (and sometimes 4, 5, and/or 6) are prepared differently and are more specialized than teachers in the lower grades.

3.2.3.1 Institutions and governance

Responsibility for teacher education in Chile is almost entirely delegated to the universities, as well as to a few tertiary-level professional institutes. During the 1990s, most teacher education in Chile took place in publicly funded universities. More recently, however, a growing number of private universities have started to provide teacher education. TEDS-M sampling information shows that when the study began in 2006, 16 public universities, 22 private universities, and 5 professional institutes offered teacher education program-types for basic education teachers.

Chile has no established government policies related to coordination of teacher education. Instead, the Ministry of Education maintains an informal relationship with teacher education institutions.

3.2.3.2 Program-types and credentials

Applicants for teaching positions must have a teaching qualification from a university or a professional institute appropriate to the level in which they are to teach. Beyond that, there are no national requirements governing appointment in schools. The Organic Law of Education (1990) defines teaching qualifications in terms of a licentiate degree in education and a teaching entitlement (*Titulo de Professor*).

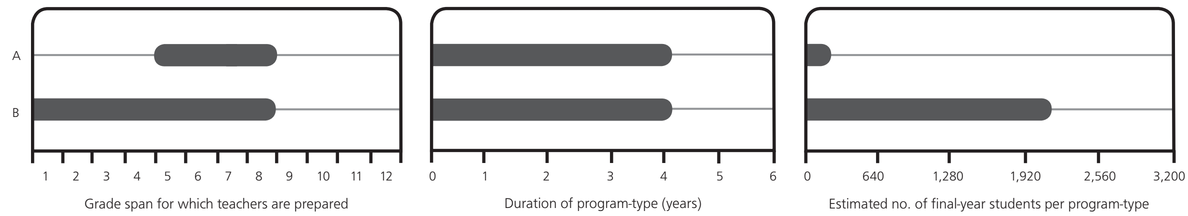
4 This section is based on the national report written by Beatrice Avalos.

In most institutions, teacher education is offered as a concurrent program-type, lasting from 8 to 10 semesters. However, as mentioned above, the main program-type prepares future teachers to teach all subjects in Grades 1 to 8, and 11 institutions offer supplementary subject-matter specialization, requiring candidates to take additional courses in a particular subject. As Exhibit 3.5 shows, both program-types serve Grades 5 to 8, but compared to the program-type for Grades 1 to 8, the program-type with additional mathematics prepares only a few teachers.

3.2.3.3 Curriculum content, assessment, and organization

Within the Chilean program-types, the offerings are similar: subject-matter knowledge, pedagogy, general education, and field experience. A semester-long or four-month practicum is required in addition to the program-long field experiences. The licentiate mandates a written thesis. Students spend the majority of their last semester on this requirement, working individually or collectively.

Exhibit 3.5: Teacher education program-types in Chile



Key to program-type
A—Generalists, but with additional mathematics education
B—Generalists

Note: According to the national research coordinator for Chile, the program-type offering extra mathematics did not include enough mathematics to warrant it being designated a specialist program-type. Estimates for the final-year students per program-type were calculated as the mean of the estimates from the two subsamples for Program-Type B.

3.2.4 Chinese Taipei [5]

Taiwan is an example of a strong centralized policy-driven teacher education system that is rigorous and competitive. Successful graduates enjoy very favorable conditions and incentives, but many others are unable to find teaching jobs.

3.2.4.1 Institutions and governance

In 2007, 59 universities in Chinese Taipei were authorized to provide teacher education. Of these, 48 universities were admitting future secondary teachers, and 23 universities were accepting future primary teachers. The current system was developed after the end of World War II and the Japanese colonial era. The Nationalist (KMT) government at that time considered the quality of teachers important to political life, economic development, and national defense, and therefore established advantageous conditions and incentives for becoming a teacher, in an effort to attract talented people to this occupation. Throughout this early period, the government exercised tight control over which institutions could educate teachers and when to increase or decrease the number

5 This section is based on the national report written by F. Hsieh, P. Lin, G. Chao, and T. Wang.

of teacher education institutions, the number of teachers being educated, and the deployment of novice teachers.

From the 1960s to the early 1990s, as the economy developed rapidly and then slumped, this rigid control was relaxed. New ideas about a free society and free economy clashed with the existing system. The government made changes to teacher recruitment, training, and employment policies and practices. For example, the ministry no longer took responsibility for assigning jobs to teachers. Instead, future teachers had to compete for specific vacancies. In short, Chinese Taipei was taking steps toward what the Organisation for Economic Co-operation and Development (OECD, 2005) has called position-based as opposed to career-based teacher employment.

3.2.4.2 Program-types and credentials

There are two types of teacher in Chinese Taipei—primary school teachers in Grades 1 to 6 and secondary school teachers who teach either lower-secondary (Grades 7 to 9) or upper-secondary (Grades 10 to 12) classes. Primary school teachers are generalists, but most secondary school teachers teach within a single level (either junior or senior high school) and a single subject. Hence, as illustrated in Exhibit 3.6, Chinese Taipei has only two program-types with respect to TEDS-M, one for primary school teachers and the other for secondary. In each one, future teachers take four years to complete the Bachelor's requirements, after which they complete the half-year practicum. Both program-types are concurrent; Chinese Taipei has no consecutive program-types.

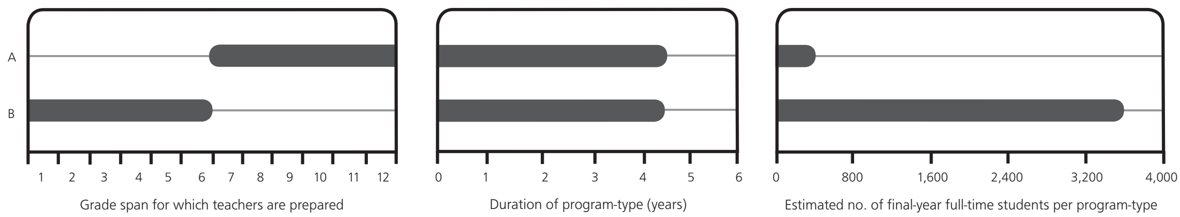
3.2.4.3 Curriculum content, assessment, and organization

Both program-types include three components. These are general curriculum requirements for all university students from any field, a subject-matter curriculum, the goal of which is to improve students' understanding of the subject(s) that they will teach, and a professional education curriculum. Universities may choose offerings from a list established by the ministry. In addition, future teachers must complete a practicum organized according to ministry guidelines.[6]

Once these requirements have been completed, future teachers have to take the Teacher Qualification Assessment. This national test is the last step in quality control of preservice teacher education. The assessment includes two general subjects and two professional education subjects. The pass rates for 2007 and 2008 were just under 68% and 76% of the future teacher cohorts, respectively.

6 These guidelines include or require policies relating to selection of practicum schools and internship supervisors, the qualifications of university supervisors (teaching staff only, no doctoral students), the qualifications of school supervisors (at least three years' teaching experience), supervision methods, the number of future teachers assigned to each supervisor, the number of hours interns spend in school each week, intern rights and obligations, procedures for handling unsatisfactory performance, intern evaluation, and the provision of counseling literature, hotlines, and internet resources to interns.

Exhibit 3.6: Teacher education program-types in Chinese Taipei



Key to program-type
A—Secondary mathematics teacher education
B—Elementary teacher education

Note: Eleven institutions in the target population were excluded because they were very small—fewer than 26 future primary teachers and fewer than five future lower-secondary mathematics teachers in the final year of their programs. The primary and secondary programs both take 4.5 years to complete. This period of time includes the four-year Bachelor's degree and a six-month practicum.

3.2.5 Georgia[7]

Georgia has been undertaking educational reforms that are drastically changing policies and practices inherited from the Soviet Union. Although the reforms are far from being completely implemented, the implications for teacher education are profound.

3.2.5.1 Institutions and governance

Ten institutions of higher education currently offer teacher preparation in Georgia. These are mostly state institutions but there are also some private ones. The 2004 Law on Higher Education of Georgia mandated major changes in teacher education. Also, for the first time, the State Commission on Educational Facilities set upper limits on the number of teacher education students to be admitted to each university. Within these upper limits, institutions determine the actual number of students admitted. Institutions previously had complete autonomy in this respect.

3.2.5.2 Program-types and credentials

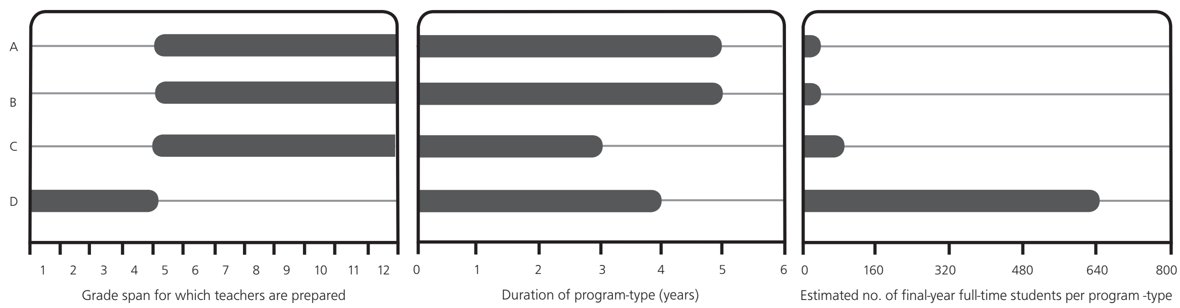
Candidates holding a Bachelor's degree in pedagogy or any other subject can become primary school teachers. They do not need any other certificate issued by the authorities. However, teaching is becoming a more regulated profession. The qualification being implemented for secondary school is a Master's degree in teaching. This requirement greatly increases the role of educational sciences in the preparation of secondary teachers.

Even under the new law, a person holding a Bachelor's remains eligible to teach Grades 1 to 6 and, until 2014, in secondary school. Once implemented, the new law will require any person entering a teaching career to pass a teacher certification examination after he or she has received a relevant degree and completed a one-year probationary period in school.

7 This section is based on the national report written by N. Mzhavanadze and T. Bokuchava.

Given this complex, changing situation, where preparation for teaching still takes place in a wide range of departments, the TEDS-M sample for Georgia was defined in terms of four program-types (Exhibit 3.7): a four-year Bachelor of Pedagogy for future primary school teachers of Grades 1 to 4, and a Bachelor of Mathematics and two Master's degrees in teaching at the secondary school level. [8,]

Exhibit 3.7: Teacher education program-types in Georgia



Key to program-type
A—Master's in Mathematics Teaching, consecutive
B—Master's in Mathematics Teaching, concurrent
C—Bachelor's in Mathematics
D—Bachelor's in Pedagogy

Note: During the current transitional period of educational reform in Georgia, future teachers in the Bachelor of Mathematics program will be qualified to teach Grades 1–12. However, according to the national research coordinator for Georgia, these students are typically found in Grades 5–12 and therefore the TEDS-M classification of level needed to be secondary, not primary–secondary. The Master's in Mathematics is a very small program that exists in only two institutions. It is listed twice in this figure because in one institution it is consecutive and in the other is concurrent. The Russian and Azeri sections of the targeted institutions have been excluded from this figure, but they accounted for only 1.4% and 1.7% of the TEDS-M primary and lower-secondary full-time student cohorts, respectively.

3.2.5.3 Curriculum content, assessment, and organization

Each institution establishes its own entrance standards and requirements. In general, there are no specific content area requirements and no tests of prerequisite subject-matter knowledge for entrance into teacher education institutions. Applicants must have successfully completed a more general national examination. Institutions also develop their curricula independently. Each unit within a university department of education decides on the number and content of courses while, in principle, taking into account the professional standard in mathematics, the national teacher standard, and the student standard (created by the Ministry of Education and Science).

The traditional Bachelor's degree in education in Georgia typically takes 36 months to complete and includes two phases, an academic phase and a nine-month practical training phase. However, the practical training phase has fallen into disuse.[9]

8 Out of 10 institutions, 9 offered four-year programs while one institution offered the same program-type as one five years in duration.

9 Chavchavadze State University, for example, decided to discontinue the period of practical training. Its instructors have compensated for this by using case studies, open lessons, and other practical experiences during the academic year.

Although examinations are administered semester by semester throughout the program-type, there is also a national examination that candidates must take in order to complete their Bachelor's degree. Practical training, when it was implemented, was also supposed to be sanctioned by an examination administered by the institution. However, as mentioned above, the new system will have an entirely new teacher certification test, consisting of a professional skills test and a subject-matter test.

3.2.6 Germany[11]

German teacher education differs markedly from teacher education in the other TEDS-M countries in a variety of important respects. Also, because education policy in Germany is basically the responsibility of the 16 federal states, and because the primary and secondary school system is highly differentiated, the system also varies internally.[12]

3.2.6.1 Institutions and governance

Because the federal government does not make educational policy, the development and coordination of common features are fostered by the Conference of [State] Ministers of Education and Cultural Affairs (KMK). In teacher education, the KMK has facilitated a national agreement (although with some allowance for variation) on the structure and duration of teacher education program-types, required coursework, and general contents of the program-types. The agreement also covers the main features of the two state examinations that future teachers must pass.

Notably, Germany is the sole TEDS-M country that appears to offer consecutive program-types only. All future teachers begin their preparation in one of the German universities with program-types that emphasize academic, theoretical study. This approach ensures a relatively advanced level of academic preparation for all future teachers given that university entrance is still selective in Germany, and especially so when compared to countries where universities reach a much larger proportion of the age cohort. Germany has 74 universities providing preservice teacher education. This first phase also contains a great deal of required education coursework that is characteristic of concurrent program-types in other systems, albeit with a heavy emphasis on theory. Most of the practical preparation is provided in a second phase in special, generally small, institutions operated by state governments and known as *Studienseminare*.[13] Thus, despite appearing to have only consecutive program-types, Germany should be understood as having program-types that are not purely consecutive but rather a hybrid of concurrent and consecutive types.

11 This section is based on the national report written by J. König and S. Blömeke.

12 The integration of Germany into European higher education, according to the Bologna Accord, is changing some of these traditional characteristics. This account represents the situation at an earlier point in time.

13 Two states do not have these institutions; instead pre-university schools take responsibility for the second phase.

3.2.6.2 Program-types and credentials

In Germany, teaching careers and, therefore, teacher education program-types, differ from one type of primary or secondary school to another. The German *Grundschule* or primary school ends at Grade 4 in most German states, and is shorter than the international norm. All *Grundschule* students attend the same type of school; there is no stratification at this point. However, at Grade 5, students are stratified into four very different types of school: (1) *Hauptschule*,[14] (2) *Realschule*,[15] (3) *Gymnasium*,[16] and (4) *Gesamtschule*.[17] In some states, the *Hauptschule* and *Realschule* are combined.

In order to staff these different types of school,[18] the KMK has classified teaching qualifications into four categories:[19]

- Type 1: Primary (*Grundschule*) only, Grades 1 to 4;
- Type 2: Primary (*Grundschule*) or lower-secondary schools, Grades 1 to 9/10;
- Type 3: All types of lower-secondary school, Grades 5 to 9/10;
- Type 4: Grades 5 to 12/13.

Under the TEDS-M configuration of program-types, the first two types in the German terminology were each subdivided into two TEDS-M program-types. These were future teachers with mathematics as a teaching subject and those teachers without, thus producing six program-types in all, as featured in Exhibit 3.8. Before entering any of these program-types, all future teachers have to earn the *Abitur* secondary school completion diploma, which requires passing a high-stakes examination in at least four subjects.[20]

3.2.6.3 Curriculum content, assessment, and organization

Because Type 1 teachers teach all subjects, the study of mathematics as well as other subjects is usually compulsory for future primary teachers. Type 2 teachers preparing for Grades 5 to 10 and all Type 3 and 4 future teachers are more specialized than their Type 1 colleagues and undertake study that allows them to teach two subjects. Before the Bologna Accord, future teachers did not progress through this phase in cohorts, nor were they required to attend classes. This first university phase typically lasts from 42 months for primary to 54 months for secondary future teachers. These time periods include breaks and vacations.[21]

14 This is the least academic and most practical type of lower-secondary education for Grades 5 to 9, accounting for 26% of eighth graders in 2006, according to the *TIMSS 2007 Encyclopedia*. On completing their schooling at this level, *Hauptschule* students either combine work with part-time vocational training or go straight to a full-time vocational school.

15 This is a more selective form of secondary education for Grades 5 to 10, with 27% of eighth graders attending these schools. *Realschule* is considered an appropriate basic education for lower levels of white-collar and technical occupations.

16 This constitutes the élite form of secondary education, with 33% of eighth graders preparing for the *Abitur*, which is required for university entrance.

17 This, a comprehensive school, provides differentiated programs otherwise offered in separate schools. Comprehensive schools take in about nine percent of eighth graders, but do not exist in all German states.

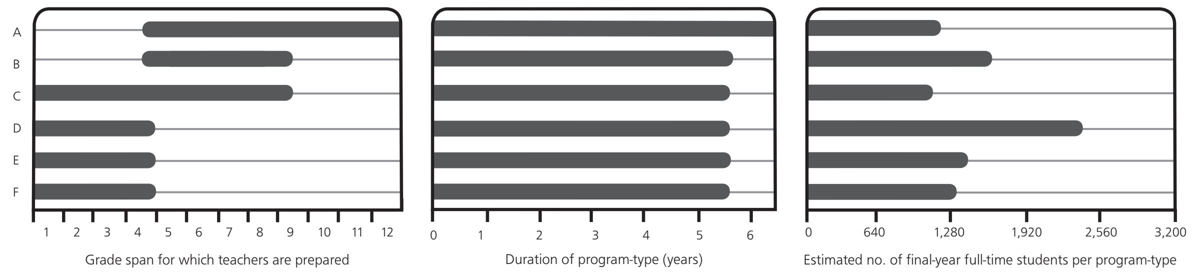
18 Excludes vocational and special education because TEDS-M does not include teachers prepared for these programs.

19 There is no longer a direct correspondence between types of school and types of teacher education in the sense of drawing *Gymnasia* teachers solely from one type, for example. Nevertheless, new teachers in *Gymnasia* are more likely to come from Type 4 programs than from other types.

20 The nature and organization of this examination vary from state to state, but some commonality has been established through an interstate compact between the federal states.

21 Breaks are counted because future teachers have assignments to complete during their breaks (seminar papers or school-based experiences).

Exhibit 3.8: Teacher education program-types in Germany



Key to program-type

A—Grades 5/7–12/13 with mathematics as a teaching subject (Type 4)
B—Grades 5/7–9/10 with mathematics as a teaching subject (Type 3)
C—Grades 1–9/10 with mathematics as a teaching subject (Type 2A)
D—Grades 1–4 without mathematics as a teaching subject (Type 2B)
E—Grades 1–4 without mathematics as a teaching subject (Type 1B)
F—Grades 1–4 with mathematics as a teaching subject (Type 1A)

Note: For organizational reasons, one small federal state could be included only at the institutional level. No further teacher data were collected, but this information would have accounted for only 3.7% of the TEDS-M primary population and for a similar percentage at the lower-secondary level. The grade span for primary school teachers is Grades 1 to 4, except in two states where primary school includes Grades 1–6. The duration of Type 1A and Type 2B programs is the same (3.5 + 2.0 years) in all federal states except one. The duration of Type 2A and 2B programs varies across federal states from 3.0 to 4.5 years for Phase 1 and 1.5 to 2.0 years for Phase 2. The values shown in the graphs are modal values. The duration of Type 3 is the same (3.5 + 2.0 years) for all but three federal states. In two of these states, the duration of Phase 1 is 4.0 years. In the other two states, the duration is 1.5 years. The duration of Type 4 is the same (4.5 + 2.0 years) for all federal states except one. Estimates for final year full-time students per program-type were calculated as the means of the estimates from the two split-half samples for Program-Type 2A (or bar C above).

The second phase lasts 18 to 24 months, depending on the state and level of teacher education. Future teachers in this phase teach part-time in schools, assuming all the responsibilities normally expected of a classroom teacher. They simultaneously attend courses in general pedagogy (*Hauptseminar*) and subject-specific pedagogy (*Fachseminar*) organized by their *Studienseminar*.

During teacher education, future teachers must pass two state examinations to be considered qualified to teach. They undertake the first state examination at the end of the first university phase. It consists of several written and oral examinations related to the subjects studied in the first phase, as well as a long essay. Successfully passing this examination constitutes a first university degree at ISCED Level 5A.

The second state examination is less academic and more practical than the first. Future teachers are required to teach lessons that are observed and assessed by a board of examiners. An essay on a practical issue is also required. One or more oral examination sessions may be included as well. Successful completion of the second state examination constitutes attainment of an ISCED Level 5A second university degree.

3.2.7 Malaysia[22]

In time, Malaysia wants all of its primary and secondary teachers to be university graduates with degrees (i.e., "graduate teachers") rather than teachers who have teacher college diplomas only (i.e., "non-graduate teachers"). However, at the time of the TEDS-M survey, the non-graduate Malaysian Teaching Diploma was by far the largest of the program-types preparing primary school teachers (Exhibit 3.9).

3.2.7.1 Institutions and governance

Initial teacher education in Malaysia is conducted at two levels—public and private universities, and teacher training institutes.[23] While all public and private universities produce graduate teachers, the teacher education institutes still award non-graduate diplomas as well as Bachelor's degrees. The Ministry of Education has set a target of having, by 2015, all teachers in secondary schools and at least 50% of teachers in primary schools with the status of graduate teachers.

3.2.7.2 Program-types and credentials

Future teachers of mathematics intending to teach in Malaysian primary and secondary schools have at hand five different preservice program-types: three for primary Grades 1 to 6 and two for secondary Grades 7 to 13 (Exhibit 3.9). At the secondary level, the universities offer two concurrent program-types, the Bachelor of Science (Education) and the Bachelor of Arts (Education).[24] At the primary level, the consecutive Diploma in Education, for future teachers who already have a degree, and the Bachelor of Education are both offered to prepare future primary teachers at the graduate level. The Malaysian teaching diploma is offered to future primary teachers at the non-graduate level.

3.2.7.3 Curriculum content, assessment, and organization

The Teacher Education Division of the Ministry of Education, with approval from the ministry's Central Curriculum Committee and the Malaysian Qualification Agency (which has been responsible for accrediting all higher education offerings since 2007), sets the curriculum requirements for teacher education institutes (i.e., the former teacher colleges). The Teacher Education Division also sets requirements for ongoing implementation of the goals of two important documents—the *National Philosophy of Education* (formulated in 1988)[25] and the *Philosophy of Teacher Education* (formulated in 1982).[26] The focus in these documents is on national unity, national culture, science and technology, and individual development.

22 This section is based on the national report written by R. Nagappan, N. Ratnavadivel, O. Lebar, I. Kailani, and S. Malakolunthu.

23 The teacher education institutes are former teacher education colleges, which used to prepare teachers for primary and lower-secondary schools, credentialing them with certificates and later diplomas, but are now empowered to award Bachelor's degrees to their graduates.

24 A Post-Graduate Diploma in Education (PGDE) is also offered, but it was not included in TEDS-M because of a lack of students working toward this qualification.

25 See http://unesdoc.unesco.org/images/0019/001931/193184e.pdf

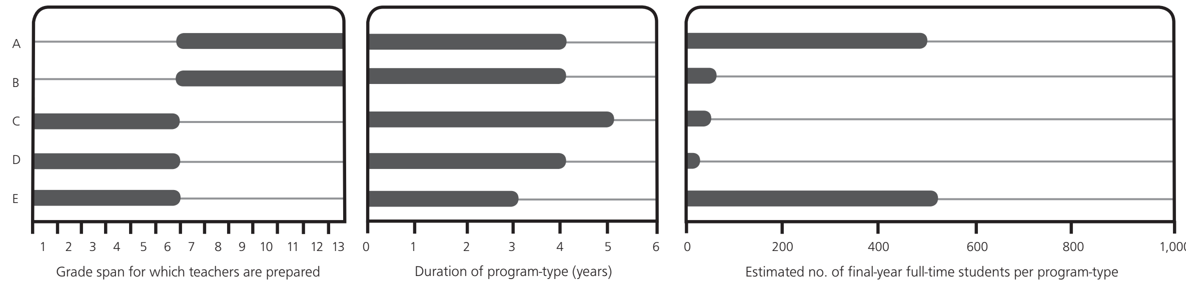
26 See http://aadcice.hiroshima-u.ac.jp/e/publications/sosho4_2-08.pdf

All teacher education institutes follow a common curriculum, which has six basic components: teacher dynamics,[27] knowledge and professional competence,[28] subject options and specialization (major and minor subjects), self-enrichment,[29] co-curricular activities, and practicum. The universities are responsible for their own curricula, but are required to develop these within guidelines set by the Malaysian Qualification Agency and the Ministry of Higher Education. Practicum requirements differ somewhat among universities and institutes. Ten to 12 weeks of practicum are the norm.

The last major policy reform affecting the teaching of mathematics was introduced in 2003, when it was decided to teach mathematics in English instead of Malay (or Chinese or Tamil in the vernacular schools) in Grades 1 to 13. Because teachers had never been expected or prepared to do this, the decision had major implications for both preservice and inservice teacher education. The policy has now been rescinded, and since the beginning of 2012 mathematics has again been taught in the other languages.

Testing and assessment in Malaysian teacher education is multifaceted. For purposes of selection, all future teachers are required to pass assessments, comprehensive examinations (oral and written) in each of the required subjects, the Malaysia Teacher Education M-Test, and the Malaysian Educators Selection Inventory (MEdSI). In addition, each institution requires its future teachers to submit a portfolio and to pass an assessment of their classroom teaching competence. Future teachers furthermore experience continuous assessment of their knowledge and skills during each of their courses.

Exhibit 3.9: Teacher education program-types in Malaysia



Key to program-type

A—Bachelor of Science in Education (Mathematics), secondary
B—Bachelor of Arts in Education (Mathematics), secondary
C—Diploma of Education
D—Bachelor of Education, primary
E—Malaysian Diploma of Teaching (Mathematics)

Note: The Bachelor of Education Teaching English as a Second Language (TESL) with mathematics program-type was not included in the TEDS-M target population. The Malaysian Postgraduate Diploma of Teaching (Mathematics) was also excluded because it had no eligible future teachers at the time of testing.

27 That is, language skills, thinking skills, environmental education, Islamic civilization, Islamic education or, alternatively, moral education for non-Muslim students.

28 Learning about Malaysia, psychology, pedagogy, guidance and counseling.

29 Art, physical and health education.

3.2.8 Norway[30]

Norway has a national framework (*rammeplan*) for teacher education, which all institutions follow. However, each institution has a great deal of autonomy with regard to organizing the content and the structure of the subjects taught, although there is less autonomy than before.

3.2.8.1 Institutions and governance

Norway has seven universities and 27 university colleges. Two universities and 17 university colleges (*lærerhøgskoler*) offer the general teacher education program-type (*allmennlærer-utdanning* or ALU), designed to prepare future teachers to teach mathematics (as well as other subjects) in both primary and lower-secondary schools. All seven universities provide preparation for lower- and upper-secondary school teachers.

3.2.8.2 Program-types and credentials

Norway has four major program-types for teacher education (Exhibit 3.10). The ALU program-type for primary and lower-secondary school teachers is concurrent; it provides future teachers with four years of general subject knowledge, pedagogy, and subject didactics. Teaching practice is included every year.[31]

All ALU students choose optional subjects during their third and fourth years, providing students with opportunity to obtain more depth in one of the subjects. Some students choose mathematics. In TEDS-M, these students were considered a population of their own and were tested two years later than the ALU future teachers who had not yet reached the year when they could opt (or not) to choose mathematics. These two program-types have an extended grade range (1 to 10), which coincides with the compulsory school system in Norway and includes the lower-secondary school phase of basic education.

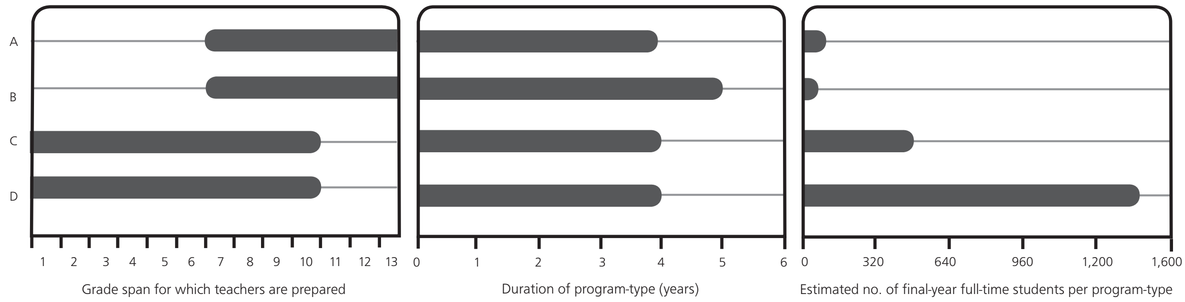
The third program-type is a concurrent five-year Master's degree offered by the universities. The fourth program-type is consecutive. It provides future teachers with a subject-specific education (*adjunkt* or *lektor*) that prepares them for work in lower- and upper-secondary schools (Grades 8 to 13). The final year (PPU) contains pedagogy, subject-matter didactics, and teaching practice. The last two program-types normally provide qualification in two teaching subjects. However, as Exhibit 3.10 shows, these two program-types prepare very few future teachers when compared to the ALU.

---

30 This section is based on the national report written by T. Breiteig.

31 Note that the numbers do not correspond to the number of institutions in the TEDS-M database. This is because, unlike in other TEDS-M countries, if the same institution in Norway offered more than one program-type, it was counted for TEDS-M purposes as more than one institution.

Exhibit 3.10: Teacher education program-types in Norway



Key to program-type

A—Teacher Education Program (PPU)

B—Master's degree

C—General teacher education (ALU+) with mathematics option

D—General teacher education (ALU) without mathematics option

Note: The most common PPU program-type is one in which future teachers first complete a Bachelor's degree in mathematics and another subject (three years) and then continue on with the PPU course (one year). However, students can elect to complete a Master's degree (five years) before taking the PPU course (one year). The Master's and PPU program-types formally qualify graduates for Grades 5–13, but almost all graduates end up teaching Grades 8–13. Future teachers in the ALU without extra mathematics were tested at the end of the second year of the program whereas the full-time students in the ALU without mathematics were tested at the end of the fourth and final year of the program. Thus, these two program-types overlap because those students in the ALU without extra mathematics in Year 2 can choose ALU with mathematics in Years 3 or 4. Estimates for final-year full-time students per program-type were calculated as the mean of the estimates from the two split-half samples for Program Types C and D.

Because Norwegian institutions enjoy a high level of autonomy, they are responsible for the quality of what they offer. The links between internal and external quality assurance are maintained through the Norwegian Agency for Quality Assurance in Education (NOKUT). However, there is no requirement to test or check particular skills or knowledge at the end of the teacher education program-types.

The 2003 national curriculum framework addresses the competencies teachers should acquire; they do not specify subject-matter content. The institutions themselves are responsible for designing the content that enables future teachers to acquire the competencies. They are also responsible for demonstrating compliance with the frameworks. Nevertheless, universities typically resemble one another in terms of teacher education by offering an ordinary academic degree followed by "practical pedagogical education" (PPU). In university colleges, teacher education takes four years. Compulsory subjects such as pedagogical theory, mathematics, Norwegian, and religion account for half of the program-type. These required courses include subject-matter didactics. The rest are elective courses. Guided practice takes place during the 20 to 22 weeks of the program-type.

3.2.9 Oman[32]

A small number of institutions with evolving roles are responsible for teacher education in Oman. All graduates of program-types that fit the TEDS-M population have Bachelor's degrees, but the program-type offered by colleges outside the university differs in certain respects from that offered at the university (e.g., language of instruction and practicum requirements).

3.2.9.1 Institutions and governance

Oman currently has no initial teacher education provision for Grades 1 to 4. The reason is insufficient demand for new teachers at this level. TEDS-M, therefore, encompassed Grades 5 to 12 only. Recently, Oman's six colleges of education were converted to more comprehensive applied colleges of science. Five of them no longer offer teacher education, but at the time of the TEDS-M data collection, all six still had teacher education students in their final year and therefore participated as part of the target population. Teacher education is currently offered at only a few institutions—Sultan Qaboos University, one college for females under the Ministry of Higher Education, and three private universities.[33]

3.2.9.2 Program-types and credentials

In Oman, all secondary teachers of mathematics prepare for just one teaching subject, although they are actually required to study other subjects as well. Oman has three major program-types for preparing these mathematics teachers. One is a concurrent program-type at a college of education, leading to a Bachelor of Education (Exhibit 3.11). The second program-type also leads to a Bachelor of Education, but it is offered at Sultan Qaboos University, and the third is a consecutive program-type, consisting of a Bachelor of Science in Mathematics followed by a professional education diploma.

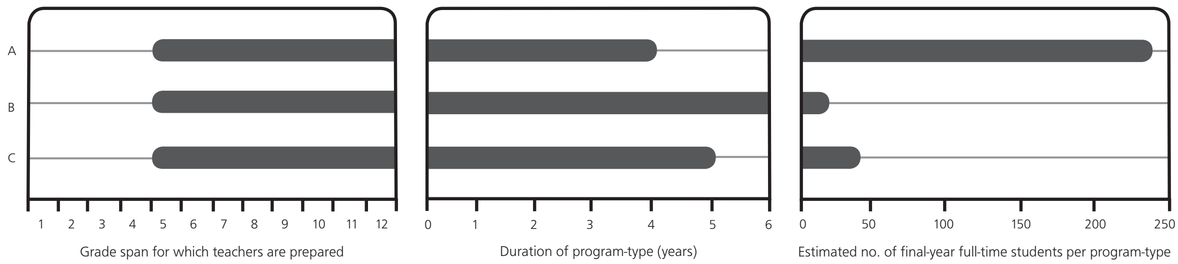
The Bachelor of Education that the university offers takes an average of five years to complete. In part, this is because most of the mathematics students have to spend one or two semesters studying English, given that English is the language of instruction for most of their courses. In the college of education, the Bachelor of Education takes four years to complete because there is less of an emphasis on English. Arabic is the language of instruction.

The Bachelor of Science in Mathematics program-type includes the normal two phases of a consecutive course of study. During the first phase, students are enrolled in the College of Science for five years, after which they receive a Bachelor's degree in mathematics. During the second phase, students enroll in the university's college of education for one additional year and then receive the Professional Educational Diploma in Mathematics. All these graduates are qualified to teach Grades 5 to 12.

32 This section is based on the national report written by M. Al Ghafri, A. Al Abri, and M. Al Shidhani.

33 The private universities had so few graduates in teacher education that they were not included in TEDS-M.

Exhibit 3.11: Teacher education program-types in Oman



Key to program-type

A—Bachelor of Education, college of education

B—Bachelor of Science, followed by Diploma in Education

C—Bachelor of Education, university

Note: At the time of testing, Oman was not offering preservice teacher training for Grades 1–4 because of insufficient demand for new teachers at that level. Programs at private universities were not included because they had very few students.

3.2.9.3 Curriculum content, assessment, and organization

The future teachers in the concurrent Bachelor of Education program-type have a heavy schedule of coursework. It includes:

- A "cultural component" of seven courses, with an emphasis on the nature of Omani society and its Arabic and Islamic origins, plus English language and elective courses;
- Specialized coursework in mathematics, physics, and computer science (20 to 21 required courses); and
- Eleven courses in education.

At the university, the practicum takes place in the final year of Bachelor of Education study (one day a week in the first semester and two days a week in the second). In the consecutive program-type, the practicum is scheduled for the last semester only and for two days a week. In the college of education, dispersed requirements for field experience that began in the third semester and continued to the end of the program-type were discontinued and replaced with the two-days-a-week requirement in the final year.

3.2.10 Philippines[34]

In contrast to most TEDS-M countries, the Philippines has a large number of teacher education institutions, both public and private. Key requirements, however, are set at the national level.

3.2.10.1 Institutions and governance

The Philippines has a total of 323 primary-level institutions offering mathematics for future teachers (72 public, 251 private) and 546 at secondary level (139 public, 407 private). Although these institutions have considerable autonomy, the Commission on Higher Education (CHED) has the legal authority to set minimum standards, evaluate what is offered, and establish policies and guidelines for the creation of new institutions.

34 This section is based on the national report written by E. Ogena and E. Golla.

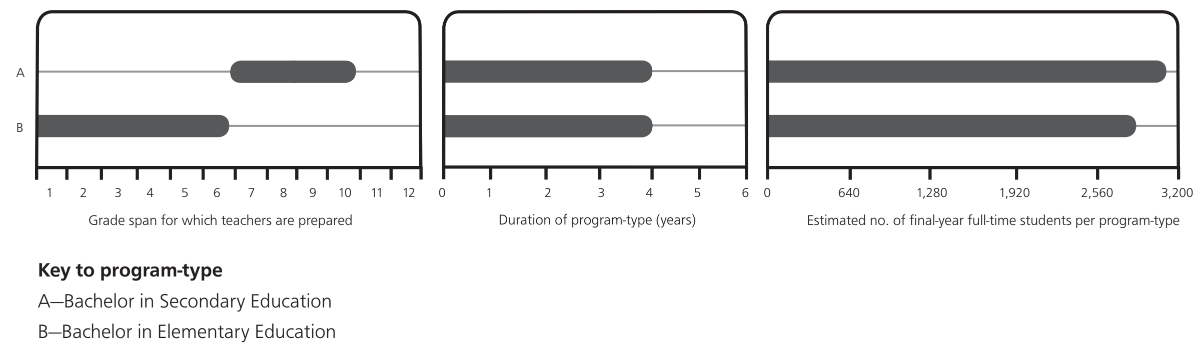
The Technical Panel for Teacher Education reviews teacher education curricula as well as the overall capabilities of teacher education institutions.

3.2.10.2 Program-types and credentials

As Exhibit 3.12 shows, the Philippines has a very simple structure of one primary program-type (Bachelor of Elementary Education) for Grades 1 to 6 and one secondary program-type (Bachelor of Secondary Education) for Grades 7 to 10, both of which take four years to complete and are concurrent. The Bachelor of Secondary Education requires candidates to take a major subject, and sometimes a minor specialization; a few institutions require two major specializations.

Because secondary school in the Philippines ends at Grade 10, students are eligible for vocational training or university. Future teachers, therefore, go into teacher training after Grade 10, but they continue with basic general education courses in their first year, before beginning to specialize.

Exhibit 3.12: Teacher education program-types in the Philippines



Note: Sixty-one institutions in the target population were excluded because they were very small (fewer than five primary future teachers and fewer than three lower-secondary teachers).

3.2.10.3 Curriculum content, assessment, and organization

In 2004, a CHED directive required implementation of a new curriculum in 2005/2006.[35] This includes a 6- to 12-week student teaching requirement. Student teaching includes both on- and off-campus components. Although there are guidelines for assessing this practicum component, much of the assessment is ad hoc, according to the authors of the country report.

All primary and secondary teaching candidates are required to take the Licensure Examination for Teachers (LET). The LET includes three main tests—professional education, general education, and the field of specialization—and is weighted 40%, 20%, and 40%, respectively. The syllabus is publicized and made known to teacher education institutions.

35 The earlier curriculum, at the beginning of the 1990s, was thought to be too heavy in general education courses, without enough specialized coursework or enough field experience. More subject-matter content was added to the program-types in the subsequent reform. The new curriculum also emphasizes curriculum development, lesson planning, instructional materials development, assessment, and innovative teaching, and gives greater emphasis than previously to experience in the field and in classrooms.

3.2.11 Poland[36]

In Poland, specialists teach mathematics from Grade 4 on. Poland thus differs from the norm in other TEDS-M countries with respect to the knowledge expected of teachers who staff most of the basic education grades.

3.2.11.1 Institutions and governance

Higher education plays a major role in teacher education in Poland. Although teacher training colleges, which are not considered to be a part of higher education, also offer teacher education, they produce only a small number of teachers. Students in teacher training colleges follow a curriculum that is very similar to the curriculum of Bachelor-degree studies. Their graduates are awarded a diploma (*dyplom ukończenia kolegium nauczycielskiego*). Recent reforms have raised the qualification levels required for entry into teaching, but there is no licensing; qualifications are defined solely in terms of required higher education degrees. Teacher education operates within the general legal and institutional framework of higher education. Special regulations of the sort developed for all fields of study set out the requirements for the curriculum and practicum of teacher education.

3.2.11.2 Program-types and credentials

The organization of primary and secondary education changed in 1999. Primary schools in Poland now offer six years of general education, with a further three years in lower-secondary schools. Primary school has two stages: a stage of integrated learning in Grades 1 to 3 and a stage of specialist subject teaching in Grades 4 to 6. Future teachers wanting to teach mathematics in Grade 4 must complete a higher education degree in mathematics, which also includes required teacher education content.[37] Graduates in mathematics education from the teacher education colleges can teach only in Grades 4 to 6 of the primary schools and in basic vocational schools. In contrast, there is no distinction in Grades 1 to 3 between school subjects; teachers must be qualified in "integrated teaching"—a qualification acquired through pedagogical-study program-types at Bachelor's and Master's levels in universities or at diploma level in teacher education colleges. The pedagogical-study program-types include very little opportunity to learn mathematics, but provide substantial academic knowledge in general pedagogy.

A two-cycle structure has been introduced as part of Poland's implementation of the Bologna Accord—a three-year Bachelor of Arts (second and fourth bars in Exhibit 3.13) and a two-year Master of Arts. The first-cycle (Bachelor's) degree in mathematics qualifies graduates to teach in primary and lower-secondary schools, while the second-cycle (Master's) degree in mathematics qualifies graduates to also teach in upper-secondary schools. The pedagogy degrees usually qualify teachers to teach in kindergartens and Grades 1 to 3. The old five-year Master's has been phased out (first and third bars in Exhibit 3.13). While this program-type is no longer offered, it was included in TEDS-M because students were still completing their final year of study in 2008. Graduates of the first cycle (Bachelor's) programs may enroll in second-cycle (Master's) programs. For this reason, second-cycle program-types were not included in the TEDS-M study because they are offered mostly to persons already qualified to teach.

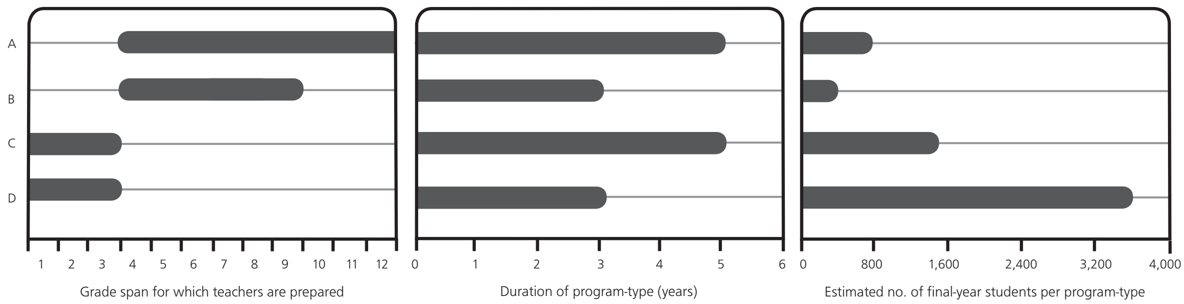
36 This section is based on the national report written by M. Sitek.

37 Majoring in a degree with substantial mathematics content can also be considered satisfactory. This determination is made by the school principal, who is responsible for teacher employment.

In the first-cycle Bachelor's program-type, future teachers prepare to teach two subjects. The more advanced degree prepares them for even more specialization in just one subject (although they still may also teach two). Exhibit 3.13 shows that the top two program-types (or bars) preparing future teachers for Grades 4 to 12 and 4 to 9, respectively, are relatively small program-types, compared to those represented by the third and fourth bars in the exhibit, which focus on Grades 1 to 3. This pattern reflects the popularity of pedagogy program-types for Grades 1 to 3, which are less selective and less demanding than the mathematics program-types.

Administrative and survey data show that most of the teachers in Poland hold Master's degrees. A survey of specialist mathematics teachers in primary and lower-secondary schools indicates that 95 and 97%, respectively, hold Master's degrees. However, many teachers of mathematics were majoring in other fields of study. As many as 31% of the primary school mathematics teachers and 25% of the lower-secondary mathematics teachers had qualified in this subject through post-graduate study. A large majority of them had previously taught other school subjects, mainly physics or other science subjects.

Exhibit 3.13: Teacher education program-types in Poland



Key to program-type

A—Master's in Mathematics, long cycle

B—Bachelor's in Mathematics, first cycle

C—Pedagogy, integrated teaching, long cycle Master's

D—Pedagogy, integrated teaching, first cycle Bachelor's

Note: Postgraduate programs and institutions with consecutive programs only were not covered (9 out of 105 institutions, making for 23.6% of the TEDS-M future primary teacher population and 29% of the lower-secondary population). Programs in teacher training colleges are not separated out from Bachelor of Arts programs in universities in the program-types because their programs are so similar and the proportion of future teachers in them is very small. Earlier in the study, a distinction was made between full-time and part-time program-types. However, in this exhibit, the full-time and part-time programs have been combined, again because the differences are not great enough to constitute separate program-types. In addition, the second cycle program-type (Master's), which was originally considered part of the target population, was ruled out of scope because most of its students had already become eligible to teach after completing the first cycle (Bachelor's). Estimates for final-year full-time students per program-type were calculated as the mean of the estimates from the split-half samples for Program-Types A and B.

3.2.11.3 Curriculum content, assessment, and organization

Teacher education is offered as a specialization within other higher education program-types, which means that a major part of the future teachers' curriculum is the same as other tracks within the mathematics field of study (or pedagogy, in the case of future teachers for Grades 1 to 3). In addition to meeting the standards set for all graduates in mathematics, students in the teacher education track must complete required coursework in pedagogy, psychology, didactics, and practicum, as defined in a decree put out by the Minister of Education. According to the TEDS-M national center in Poland, teacher education suffers from the "academic drift" of higher education (Fulton, Santiago, Edquist, El-Khawas, & Hackl, 2007). There is a greater emphasis on academic subject-matter content than on knowledge of teaching practices and related knowledge of the schools in which future teachers are likely to teach.

3.2.12 The Russian Federation[38]

The Russian Federation is transitioning from the system of teacher education that existed in the Soviet Union to a double-level system that complies with the principles of the Bologna Accord, which are being applied in many European countries. Thus, in similar vein to the situation in Poland, the old program-type of unified five-year teacher preparation, in which all of the TEDS-M sample were enrolled, has been largely replaced by a Bachelor's degree followed by a Master's degree. At the same time, most of the former pedagogical universities have become faculties of education situated in more conventional university settings.

3.2.12.1 Institutions and governance

In Russia, public universities, established at national, regional, or municipal levels, are responsible for qualifying teachers of mathematics. There are no private institutions preparing mathematics teachers in the federation. Changes made in response to the Bologna Accord have been rapid. When the TEDS sampling frame was prepared in 2006, 162 higher education institutions were preparing teachers for work in primary schools and 120 were preparing teachers of mathematics for work in basic and secondary schools. Among them were 111 pedagogical universities or institutes and 54 state universities. However, by 2009, the number of pedagogical universities preparing mathematics teachers had dropped sharply—to 62. By that time, many universities had started offering the new Bachelor's plus Master's program-type, but others were still offering the traditional five-year program-type surveyed in TEDS-M. Some universities at the time were offering both the old and the new program-types.

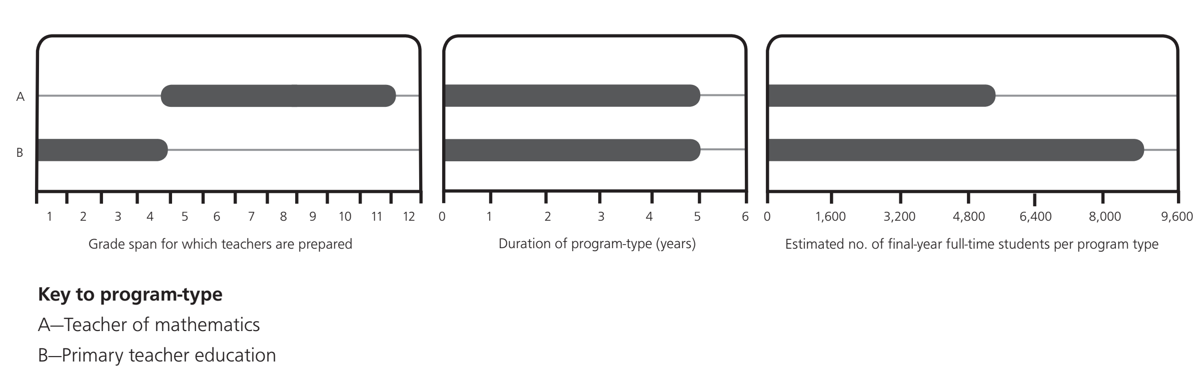
3.2.12.2 Program-types and credentials

At the time of the TEDS-M data collection, students in the new Bachelor/Master's program-type, established in 2005, had not reached their final year of study and therefore did not belong in the TEDS-M target population. The population also did not include students in the pedagogical colleges whose programs were due to be phased out. These colleges offered either four years of teacher education at secondary school level (starting at Grade 10) or three years starting immediately after secondary school (Grade 11). The number of colleges and future teachers in these college program-types at the time of data collection was unknown (the number of remaining colleges was estimated to be about 80).

38 This section was written with the assistance of G. Kovaleva.

According to the Russian Federation TEDS-M national research coordinator, many of the graduates of these colleges have continued on to the pedagogical universities, starting at these institutions in their second or third year of study. Also, at the time of data collection, an estimated five percent of newly qualified teachers were people who had a first university degree but had not studied education in any form. After a special short course, they received their qualification to teach. The TEDS-M target population, however, was defined only in terms of two program-types, both five years in duration: one for primary schools, Grades 1 to 4, and the other for secondary schools, Grades 5 to 11 (see Exhibit 3.14). Today, the universities educate both future primary school and future secondary school teachers. However, one department is responsible for the primary teachers and a different department for the secondary.

Exhibit 3.14: Teacher-education program-types in the Russian Federation



Note: Coverage of the TEDS-M target population did not include pedagogical colleges, the programs of which were about to be phased out. Nor did the population include the new Bachelor's/Master's program-types because their students had not reached their final year. Another estimated five percent of the target population that was not covered consisted of the university graduates who became qualified to teach after a special short training course.

3.2.12.3 Curriculum content, assessment, and organization

The new Bachelor's plus Master's and the old TEDS-M program-type are still based on the model developed during the Soviet era. Although the national government has a set of state standards for teacher education, each institution can select from these standards to tailor the curriculum to its own requirements and emphases, which are mediated by such factors as subject-matter specializations, research capability, and regional traditions. However, the Ministry of Education and Science must approve this choice.

The mathematics content in the state standards for teacher education is very similar to mathematics standards for other mathematics-focused professions. For example, the standards for the mathematics department of the pedagogical universities, at the Bachelor's degree level, include a two-year course in classical mathematical analysis (calculus) and its applications, a five-term course in algebra and geometry, a course in probability theory, and electives in mathematics. Special attention is paid to elementary mathematics courses during the first and seventh terms of study. There are also demanding requirements throughout the program-type for computer literacy, computer architecture, computer programming, informatics, mathematical modeling, and multimedia.

In addition, during their first two years of this program-type, students experience three terms of pedagogy and psychology. They study didactics and mathematics pedagogy during their second and third years and teaching methods specific to lower- and upper-secondary school in their third and fourth years. One month of teaching practice is scheduled in both the third and fourth years.

Under the new Master's degree program, offered during the fifth and sixth years of study, students generally have three days of instruction at the university and two to three days of practical experience at school each week. This same mixed format was used during the last academic year of the former five-year program-type. At the end of both the old and new program-types, future teachers must pass two state examinations and defend a thesis.

3.2.13 Singapore[39]

The city-state of Singapore has only one teacher education institution, the National Institute of Education (NIE), which is an autonomous institute of Nanyang Technological University. As a result, the institution has maintained a high degree of control over teacher training and certification in the nation. Teachers are recruited by the Ministry of Education and sent to NIE for training. NIE offers a number of different program-types.

3.2.13.1 Institutions and governance

Graduating from NIE automatically qualifies candidates recruited by the Ministry of Education to teach in Singapore's public schools. The permanent secretary of Singapore's Ministry of Education chairs the NIE's governing council. In general, NIE works very closely with the ministry.

3.2.13.2 Program-types and credentials

Although only one institution offers teacher education in Singapore, the structure of the program-types provided is complex (see Exhibit 3.14). Teacher education aligns with the grade split between primary and secondary education: primary education in Singapore includes Grades 1 to 6; secondary includes Grades 7 to 10. Post-secondary education includes Grades 11 and 12. Most future teachers go into teacher training after Grade 12 (A-level), but some acquire a polytechnic diploma, generally entering this course of study after completing Grade 10.

Teachers are trained in four concurrent and four consecutive program-types. The concurrent program-types include two variants of a general diploma program-type (two years) as well as a Bachelor of Arts (Education) or a Bachelor of Science (Education) degree (four years). The diploma program-type is the only concurrent TEDS-M program-type requiring fewer than three years in an institution of higher education. The primary diploma has A and C options. Students studying under the A option are trained to teach two subjects, while those studying under the C option are trained to teach three subjects.[40]

---

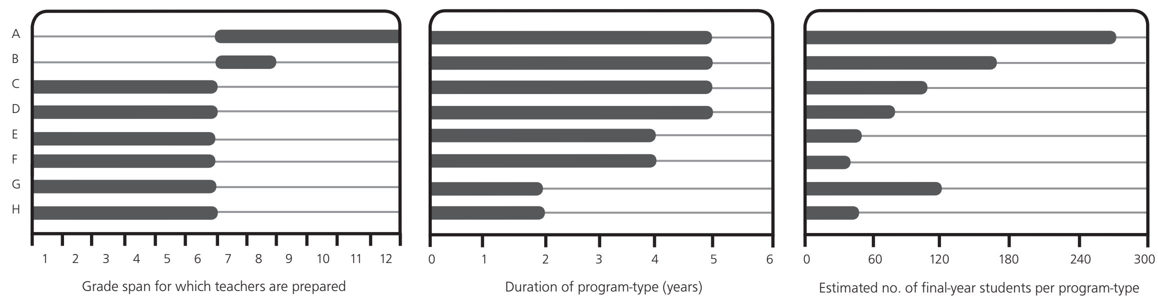
39 This section is based on the national report written by K. Y. Wong, S. K. Lim-Teo, N. H. Lee, K. L. Boey, C. Koh, J. Dindyal, K. M. Teo, and L. P. Cheng.

40 The diploma program-type is not officially recognized as being a university-level course, even though it takes place within a university. In particular, these future teachers do not complete university-level mathematics. However, those future teachers who receive the non-degree diploma are considered officially qualified to teach, even though other future teachers who obtain a university degree have a higher level of academic achievement.

Students completing the consecutive program-types receive a postgraduate diploma in education (PGDE), one form of which qualifies graduates to teach in primary schools and the other in secondary schools. The diplomas cater to future teachers who have already gained a degree and then enroll in NIE for this one-year second phase of the program-type. The top four bars in the middle chart in Exhibit 3.15 refer to the diplomas but include the four years of degree study plus one year of teacher education training, giving a typical duration of five years for this program-type.

Within the school system, about 75% of the teaching-force are graduates and the remaining 25% are non-graduates. The program-type enrollments in Exhibit 3.15 are based on the numbers of future teachers who took part in the TEDS-M survey in November 2007 and May 2008. The numbers enrolled in the various program-types in Singapore tend to change considerably from one year to the next.

Exhibit 3.15: Teacher education program-types in Singapore



Key to program-type

A—Postgraduate Diploma in Education, secondary
B—Postgraduate Diploma in Education, lower secondary
C—Postgraduate Diploma in Education, primary Option C
D—Postgraduate Diploma in Education, primary Option A
E—Bachelor of Science in Education, primary
F—Bachelor of Arts in Education, primary
G—Diploma of Education, primary, Option C
H—Diploma of Education, primary, Option A

Note: There is only one institution of teacher education in Singapore. All eight program-types co-exist in the same institution.

3.2.13.3 Curriculum content, assessment, and organization

All teacher education candidates are required to complete core courses in education studies, subject knowledge (primary only), curriculum studies, academic studies (degree only), practicum, and what are termed language enhancement and academic discourse skills (LEADS). LEADS courses are unique to Singapore. They focus on developing the skills required to use English for communication, in general, and academic and professional purposes, in particular. Emphasis on the practicum varies by program-type: diploma, 23% of total preservice education; Bachelor's degree, 16%; and postgraduate diploma, 25%.

3.2.14 Spain[41]

In Spain, state-issued guidelines direct much of the teacher education curriculum of all universities. This situation has been in force since the creation of Spain's education system in the 19th century. Multiple laws and royal decrees continue to define and develop the complex framework of this system.

13.2.14.1 Institutions and governance

Teachers in public schools in Spain are civil servants. To prepare these teachers, as well as teachers in private schools, Spain has 76 public and private institutions for primary teacher education (in faculties of education or schools of teacher education) and 28 for secondary mathematics teacher education (in faculties of mathematics). Private institutions must meet minimum conditions laid down by the Spanish government, but those not receiving public funds are free to establish their own internal rules, guidelines, and regulations. Before 2002, public institutions had to have their teacher education curricula approved by the Ministry of Education. After 2002, another public agency (the National Agency for Accreditation) took on this responsibility. Even the curriculum requirements established by and specific to individual universities must ultimately be validated by the national authorities and published in the official state gazette.

3.2.14.2 Program-types and credentials

At each level, the academic requirements for teaching are consistent throughout Spain, varying only with respect to the level of education taught. Primary education in Spain includes Grades 1 to 6. Compulsory secondary education includes Grades 7 to 12. Teacher education is aligned with these two school types. At present, a degree commonly called the teacher certificate and offering specialized preparation in primary education is required to teach students 6 to 12 years of age. Teachers at this level are generalists, usually teaching all subjects except foreign languages, physical education, musical education, and religion.

Until 2010, the teacher certificate took three years to acquire and was awarded by university schools of teacher education and associated entities. The curriculum and guidelines for this certificate dated back to 1995, and changed little in subsequent years. Secondary education candidates before 2010 were required to complete a five-year university degree and then to obtain a Certificate of Pedagogical Aptitude (CAP) at the end of a short-term course.

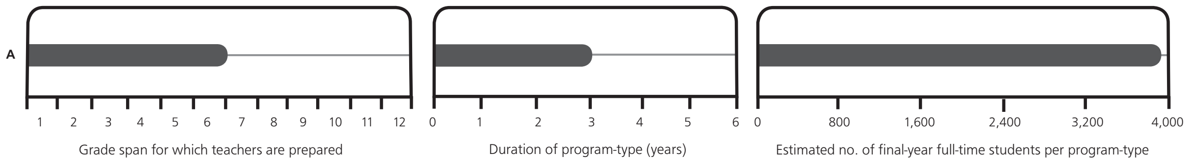
Note that TEDS-M in Spain was limited to primary education because of special difficulties anticipated in collecting data from dispersed and difficult-to-reach future teachers at the secondary level. Due to this omission, Exhibit 3.16 shows the simplest structure in TEDS-M, with only one program-type. This program-type is currently being modified and aligned with the Bologna Accord, adopted in order to "Europeanize" the continent's universities.

13.2.14.3 Curriculum content, assessment, and organization

The common core subjects for the primary teacher certificate are psycho-pedagogical foundations of special education, general pedagogy, organization of educational institutions, educational and developmental psychology and school-age development, educational sociology, educational theory and contemporary educational institutions,

41 This section is based on the national report written by E. Castro and P. Flores.

Exhibit 3.16: Teacher education program-type in Spain



Key to program-type
A—Teachers of primary education

and use of ICT in education. The specific core subjects are natural science and its didactics, social science and its didactics, artistic education and its didactics, physical education and its didactics, foreign languages and their didactics, and language and literature and their didactics. Mathematics and its didactics vary considerably from one university to another. Students must also complete a practicum. National guidelines specify that the three years of study include two weeks practicum in the first year, one month in the second, and two months in the third.

According to national policy, in order to be appointed to a teaching position in a government school, teacher certificate graduates must pass a fixed-quota competitive state examination, established to govern entry into the national civil service. The fixed quota is based on the number of vacancies in teaching available in a given year.[42]

3.2.15 Switzerland[43]

Switzerland's teacher education system has changed in fundamental ways in the last two decades, moving toward integrating teacher education in higher education, a process experienced in other countries long before this. At the same time, the Swiss have reduced, but by no means eliminated, important differences between cantons. In addition, Switzerland remains exceptional in the number of different subjects that future teachers have to study.

3.2.15.1 Institutions and governance

According to the country report, Swiss teacher training was not only diverse in the early 1990s (before the higher education integration process started) but also, in many respects, "arbitrary." There were virtually no mechanisms for coordinating and harmonizing teacher education from one canton to another. At that time, teacher training took place in 153 different institutes. Under the reform, a limited number of teacher training schools began the transformation into universities of teacher education, a process that is now almost complete.[44] Future teachers are typically required to qualify

42 This selection process takes place in three phases. The first involves a written and oral test to assess knowledge of the curriculum to be taught, as well as of pedagogical and teaching resources. The second is an evaluation of the candidates' additional qualifications (their average grades during academic studies, teaching experience outside the civil service system, and even aspects such as participation in conferences). Candidates who successfully complete these two phases continue with another period of teaching practice, for at least three months, to further verify their aptitude for teaching.

43 This section is based on the national report written by S. Brandt, F. Oser, H. Biedermann, M. Kopp, S. Steinmann, S. Krattenmacher, and C. Bruhwiler.

44 In 2004, the older teacher training schools issued 60% of the teaching certificates at the preschool and primary school levels, while the universities of teacher education issued 31% and the traditional universities 9%. Since 2006, however, teacher education for preschool, primary school, and lower-secondary school has been mainly offered at 13 universities of teacher education, and at three of the traditional universities.

for university entrance by gaining the *Matura*, a qualification awarded on the basis of passes in final examinations and students' academic record in the final year of secondary school. Students who do not have this diploma can still gain admission by sitting and passing a special entrance examination.

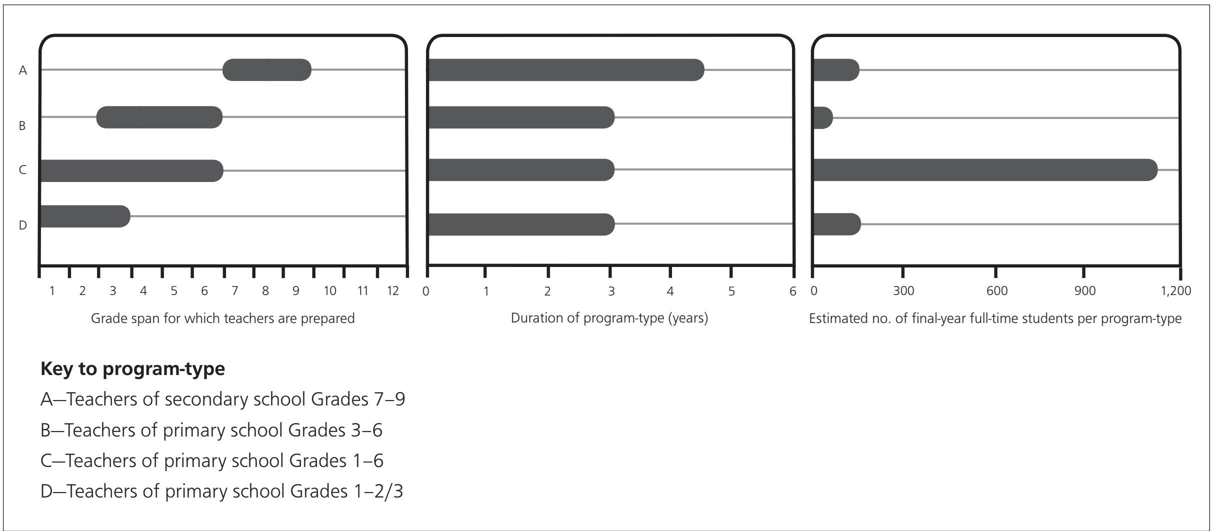
As a result of this reform, cantonal parliaments have lost some of their power over teacher education while rectors of universities of teacher education, who can now draw on increased institutional autonomy, are playing a more decisive role. The federal government has no role in teacher education other than for vocational schools. Previously, each canton decided whether to recognize the certificates of other cantons. However, the Swiss Conference of Cantonal Ministers of Education (EDK) has agreed that teaching certificates from EDK-approved teacher education institutions are now valid in every canton.

3.2.15.2 Program-types and credentials

Despite cantonal autonomy and variation, the overall structure of Swiss teacher education in the TEDS-M study (carried out only in German-speaking institutions in Switzerland) is relatively simple. It consists of the following program-types, as portrayed in Exhibit 3.17:

- Teachers of secondary school Grades 7 to 9;
- Teachers of primary school Grades 3 to 6;
- Teachers of primary school Grades 1 to 6;
- Teachers of primary school Grades 1 to 2/3.

Exhibit 3.17: Teacher education program-types in Switzerland



Note: The TEDS-M target population in Switzerland included only institutions where German is the primary language of use and instruction. It did not include institutions operating in other national languages. Also, the distinction between primary and secondary schools varies by canton: in 20 cantons, Grades 1–6 are defined as primary and Grades 7–9 are defined as secondary. However, in a number of other cantons, primary school ends at Grade 4 or 5. Some program-types at primary level qualify future teachers for kindergarten, but because this level of the education system was outside the scope of TEDS-M, no distinction was made between K–Grade 6 and Grades 1–6 programs, for example.

3.2.15.3 Curriculum content, assessment, and organization

Primary teachers teach the core primary subjects as well as music, art, physical education, and other such subjects. Lower-secondary teachers also teach multiple subjects, but they usually choose between a language–history oriented cluster and a mathematics–science oriented cluster. Future teachers preparing for primary school generally take six to eight subjects, thus putting more emphasis on a wider range of subjects than countries that concentrate on only a few core subjects. Most primary teacher education includes German, French, English and/or Italian,[45] mathematics, art, physical education, history, information technology, geography, science, and instrumental (music) instruction. Additional coursework in education is integrated into the program-types from their beginnings.

Secondary teaching candidates generally become qualified to teach three to five subjects. The combination of subjects is mandated in some institutions and is elective in others.[46] The practicum ranges from 2 to 12 weeks, with an average of seven. Some universities add on-the-job training in the social or business sectors, or foreign language study trips, to this practicum requirement.

In primary school teacher education, interim and final examinations are handled quite differently by the cantons. Some cantons have no real final examinations. In most cantons, though, examinations for primary future teachers are held for up to 10 subjects. The timing and modalities of these examinations also differ.[47] Success on a teaching test consisting of one or two lessons is required. Likewise, there are major differences in assessment across the universities offering education to lower-secondary future teachers. However, oral and written final examinations for at least three subjects take place almost everywhere. The practicum and the dissertation component of the degree are also assessed.

3.2.16 Thailand[48]

Although Thailand has a comprehensive regulatory framework for teacher education, institutions continue to enjoy considerable curricular and instructional autonomy.

3.2.16.1 Institutions and governance

In academic year 2007, 46 Thai institutions had mathematics teacher education students. Thirty-seven of these institutions offered a five-year degree, one institution offered only a one-year graduate diploma in the teaching profession, and eight institutions offered both these program-types.

45 Italian is only required within the Italian-speaking cantons.

46 In either case, this combination is drawn from a comprehensive set of subjects from the humanities and mathematics/natural sciences (mathematics, biology, chemistry, physics, and, in rare cases, information technology). Subject-matter content and subject-specific pedagogy are expected to comprise at least 40% of the program-type, the education sciences at least 20%, and practical training at least 10%.

47 They include not only written but also oral examinations, covering the general education and the profession-related parts of the program-type, which means inclusion of at least the mother tongue, one other language, mathematics, pedagogy, psychology, didactics and music, but often also drawing, physical education, history, and the natural sciences.

48 This section is based on the national report written by S. Pativisan, P. Dechsri, S. Maluangnont, and P. Talawat.

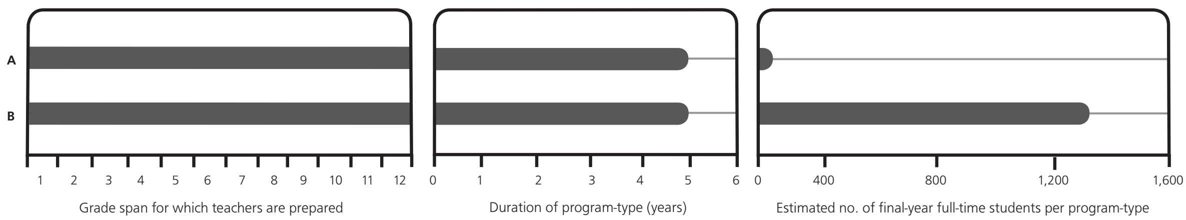
The Ministry of Education's Commission on Higher Education oversees Thai universities.[49] The Teachers' Council of Thailand is responsible for accrediting degrees and certificates, subject to guidelines set out by corresponding professional associations.

3.2.16.2 Program-types and credentials

Thai basic education follows the 6–3–3 system—six years of primary school followed by three years of lower-secondary school and three years of upper-secondary school. Nine years are compulsory. Universities with a faculty of education are responsible for preparing future teachers for both primary and secondary schools. Future teachers who have earned a Bachelor's degree outside of education must take one additional year, full-time, in a modified university program-type, which leads to a graduate diploma—the second of the two program-types included in TEDS-M for Thailand. The earlier four-year program-type was changed to five years after the 2007 class graduated. There is no differentiation between preparation of teachers for the lower grades and secondary grades up to Grade 12.

All future teachers within the Thai TEDS-M target population were specializing in mathematics, in line with a recent policy requiring teachers throughout compulsory education to be competent in mathematics. Thus, as Exhibit 3.18 suggests, the two program-types in Thailand differ only in that one is concurrent and one is consecutive.

Exhibit 3.18: Teacher education program-types in Thailand



Key to program-type

A—Graduate Diploma in Teaching, consecutive

B—Bachelor of Education, concurrent

Note: Program-types producing primary generalist teachers existed on paper, but at the time of testing and afterwards had no students. All future teachers in the TEDS-M target population were mathematics specialists. Estimates for the final-year full-time students per program-type were calculated as the mean of the estimates from the two split-half samples for Program-Types A and B.

49 The Bureau of Standards and Evaluation supervises all internal quality assessments at the universities in three domains: standards for graduation, standards for educational management, and standards for developing a knowledgeable society. In addition, the Commission on Higher Education establishes a national framework and standards for academic and professional degrees for the country's universities. That office also provides broad entry prerequisites, structure, total credits, attendance length, registration, evaluation, and graduation standards/requirements. Each institution, in turn, is responsible for specific details.

3.2.16.3 Curriculum content, assessment, and organization

Most Thai curricula for mathematics teacher education have a core of basic professional courses. The contents of these core courses are extracted from nine areas: language and technology, curriculum development, learning management, psychology, measurement and evaluation, classroom management, educational research, innovation and IT, and teacher characteristics. There is also an allowance for special topics and electives. Students must also complete a 180-day practicum during the two semesters of their last year of the five-year concurrent program-type. Students completing the graduate diploma of teaching must undertake a full-year practicum, but there is some variation in how this is implemented.

3.2.17 The United States[50]

The United States has gradually shifted from local control toward centralization of the teacher licensure or certification policy at the state and, to a lesser extent, the national level. At the same time, teacher education program-types, licensure requirements, and program accreditation requirements for primary school and lower-secondary mathematics teaching have continued to vary significantly both within and across states.

3.2.17.1 Institutions and governance

In the United States, more than 1,300 public and private colleges and universities as well as school districts, state agencies, and private organizations offer teacher education for future primary and secondary teachers. All states require teacher education institutions to obtain state approval for what they offer, but approval standards vary across states.

3.2.17.2 Program-types and credentials

In the federal No Child Left Behind legislation, the "highly qualified" teacher requirement mandates teachers to demonstrate knowledge of the subjects they are assigned to teach but does not impose specific national curriculum requirements.[51]

Exhibit 3.19 does not attempt to portray all the variations in levels of certification offered by universities and colleges in the 50 American states. Instead, it gives an overview of the six main program-types—primary, lower-secondary, and secondary, each of which is offered in both a concurrent and a consecutive version. Note, however, that the grade spans overlap: teachers in grades generally identified with primary school can thus be prepared in a lower-secondary program-type, and teachers in grades usually identified with lower-secondary can be prepared in either a lower-secondary or a lower- plus upper-secondary program-type. The content that these prospective teachers at any of these grade levels study can therefore vary considerably.

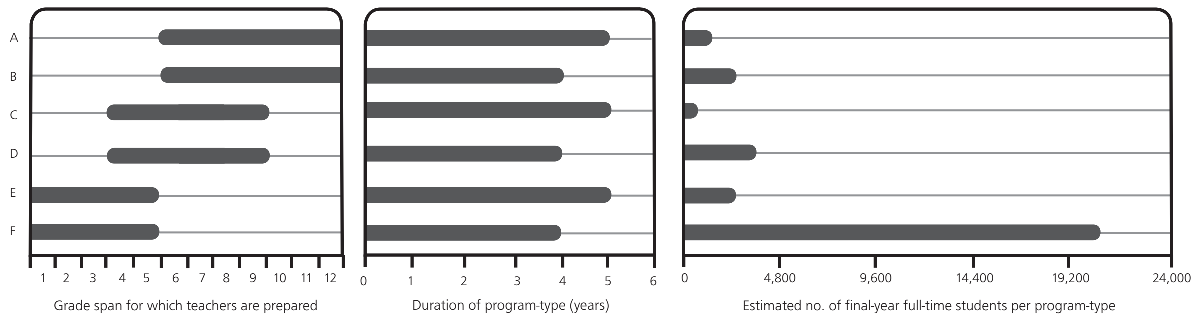
50 This section is based on the national report written by P. Youngs and E. Grogan.

51 Instead, primary candidates can demonstrate knowledge of mathematics (and other subjects) by completing a Bachelor's degree and passing tests of subject-matter knowledge and teaching skills in mathematics, reading/language arts, and writing. Secondary mathematics teaching candidates can demonstrate subject-matter knowledge by passing a subject-matter examination, majoring in mathematics as an undergraduate, earning a graduate degree in mathematics, completing the coursework equivalent to an undergraduate degree, and/or holding advanced board certification from the National Board for Professional Teaching Standards (NBPTS) or the American Board for Certification of Teacher Excellence (ABCTE).

Aside from the mandatory completion of upper-secondary school, teacher education applicants in the United States have to comply with the additional and varying requirements set by both teacher preparation institutions and the states. These include, for example, minimum grade point average, previous course requirements, scores on university entrance examinations (SAT/ACT), and, in some cases, state test scores.

In addition to the more traditional program-types in higher education, alternate routes to certification or licensure have grown significantly. States have differentially defined these routes in order to meet the demand for teachers in specific high-need subject areas or high-need locations. Alternate routes provide professional training to individuals who have been hired as the official teacher or teacher of record in a classroom. These routes were excluded from TEDS-M. Since 1998/1999, the number of teachers licensed through alternate routes has climbed steadily: in 2004/2005, approximately 50,000 teachers (about 33% of all teachers hired that year) entered through such routes. Local school districts, intermediate school districts, state agencies, private organizations, and institutions of higher education offered these options.

Exhibit 3.19: Teacher education program-types in the United States



Key to program-type

A—Secondary, consecutive
B—Secondary, concurrent
C—Primary and secondary, consecutive
D—Primary and secondary, concurrent
E—Primary, consecutive
F—Primary, concurrent

Note: The enrollments in the graphs are for public institutions only. Because of limited funding, the sample of future teachers was drawn from all public colleges and universities with teacher-education programs. The sample represented just over 60% of the total production of both future primary and future secondary teachers from all types of colleges and universities. Exclusions included (a) private institutions of teacher education and (b) alternate routes of preservice education conducted outside institutions of higher education. The different grade spans in this exhibit reflect the fact that grade spans are regulated by the certification requirements of each state. Some United States program-types at primary level qualify future teachers for kindergarten, but because kindergarten was outside the scope of TEDS-M, no distinction was made between K–Grade 5 and Grades 1–5 programs, for example. Estimates for final-year full-time students per program-type were calculated as the mean of the estimates from the two split-half samples for Program-Types C and D.

3.2.17.3 Curriculum content, assessment, and organization

In general, the primary and lower-secondary program-types differ substantially from program-types providing secondary mathematics preparation. The latter are specialist program-types that primarily emphasize coursework in mathematics, mathematics pedagogy (methods), and some additional education courses (e.g., special education, social foundations of education, multicultural education). Primary school and middle-grade program-types prepare generalists and include pedagogy (methods) courses for language, arts, social studies, and science (as well as mathematics), along with other education courses. They offer fewer courses in mathematics content than do program-types that prepare teachers for up to Grade 12.

Program-type requirements vary in other respects as well. Some states provide general guidelines, while others mandate specific requirements concerning liberal arts courses, subject-matter courses, and pedagogy courses. Teacher preparation programs, program-types, and states also vary with regard to requirements for practicum experience. As of 2007/2008, 39 of the 50 states required 5 to 18 weeks of student teaching, 38 required candidates to pass tests of basic literacy and numeracy, and 41 mandated that candidates pass tests of content knowledge. Three states did not require candidates to pass either type of test.

3.4 Conclusion

The main point of this chapter has been to show that, notwithstanding commonalities in the major organizational parameters, employment conditions, and quality assurance policies examined in Chapter 2, the TEDS-M teacher education systems differ in many other relevant ways. Understanding these differences is essential if we are to give valid interpretations of the findings of the TEDS-M curriculum analyses and surveys of institutions, teacher educators, and future teachers. However, understanding this diversity at the national level is only the first step. As the curriculum analysis and survey data will show, there is much more variation within countries. Understanding these other differences is important in terms of understanding the opportunities to learn and outcomes at the program-type, program, and future teacher levels. All this will be analyzed and reported in the remaining chapters of this publication as well as in other TEDS-M reports. This material is explored in particular depth in the national reports written and released by the participating national centers.

References

Fulton, O., Santiago, P., Edquist, C., El-Khawas, E., & Hackl, E. (2007). *Review of tertiary education: Poland*. Paris, France: Organisation for Economic Co-operation and Development (OECD).

Ingvarson, L. C., Schwille, J., Tatto, T., Rowley, G., Peck, R., & Senk, S. (forthcoming). *An analysis of teacher education content, structure, and quality assurance arrangements in TEDS-M countries*. Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA).

Organisation for Economic Co-operation and Development (OECD). (2005). *Teachers matter: Attracting, developing and retaining effective teachers*. Paris, France: Author.

CHAPTER 4:

CHARACTERISTICS OF TEACHER EDUCATION PROGRAMS, TEACHER EDUCATORS, AND FUTURE TEACHERS

4.1 Chapter Overview

This chapter focuses on the characteristics of teacher education programs in the countries that participated in TEDS-M. It also focuses on the backgrounds of the teacher educators who work in those programs and on the backgrounds of the future teachers enrolled in the programs. The data for this chapter come from four questionnaires administered as part of the study: the Institutional Program Questionnaire (IPQ), the Future Primary Teacher Questionnaire, the Future Lower-Secondary Teacher Questionnaire, and the Teacher Educator Questionnaire. The questionnaires were administered in 500 teacher preparation institutions in the participating countries to 15,163 future primary teachers, 9,389 future lower-secondary teachers, and 5,190 teacher educators. Some of the exhibits relevant to this chapter appear in Appendices A and B to this volume.

4.2 Institutional Program Structures and Characteristics

For purposes of this study, a *teacher education institution* was defined as a secondary or post-secondary school, college, or university that offered a program or programs focusing on teacher preparation on a regular and frequent basis. Within each of the sampled teacher-education institutions, there might be one or more programs provided. A *program* was defined as a specific pathway within an institution that required students to undertake a set of courses and experiences that led to the award of a teaching credential or degree upon successful completion. For example, an institution might provide a concurrent program preparing primary teachers, a concurrent program preparing lower-secondary teachers, and a consecutive program accepting graduates from tertiary institutions and preparing them to be lower-secondary school teachers. (For more detail on definitions, see Tatto, Schwille, Senk, Ingvarson, Peck, and Rowley, 2008.)

4.2.1 Institutions Sampled

Exhibits B.2 and B.3 in Appendix B present summary statistics for the national samples of participating institutions (for more detail on sampling, see Tatto, 2012). Seven hundred and fifty-one programs from 493 institutions were included in one or more of the institutional surveys: thus, each institution submitted one or more completed IPQs. In total, 349 programs preparing future teachers to teach exclusively at the primary school level submitted IPQs, 226 programs preparing future teachers to teach at the lower-secondary school submitted IPQs, and 176 programs preparing future teachers to teach at either the primary or the lower-secondary levels submitted IPQs.

The institutional data reported in the chapter are presented at the national level. Later chapters provide more detailed descriptions of opportunities to learn, as designed within the program-groups described in Chapter 2. Because of the within-country differences across teacher education program-groups discussed in Chapters 2 and 3, we decided not to use whole-country comparisons when reporting on the institutional and future teacher data. Instead, we elected to compare program-groups cross-nationally, according to the intended grade level and area of specialization (in mathematics) of the future teachers: that is, teachers who will undertake similar roles once qualified.

Data show that most future teachers planning to work in primary schools are prepared as generalists who, once qualified and depending on the country, will teach classes no higher than Grade 4 or 6. In a few countries, generalist teachers qualify to teach both primary and lower-secondary grades through to Grade 10. In others, future primary teachers are qualified to work as specialist teachers of mathematics. In contrast, most future teachers of mathematics at the lower- secondary level are prepared as mathematics specialists. Some will be qualified to teach up to Grade 10, while others will be qualified to teach to Grade 11 and above.

In this chapter, the IPQ findings and the findings from the future teachers' surveys are presented according to six program-groups:

- Group 1: Lower-primary generalists (Grade 4 maximum)
- Group 2: Primary generalists (Grade 6 maximum)
- Group 3: Primary/lower-secondary generalists (Grade 10 maximum)
- Group 4: Primary mathematics specialists
- Group 5: Lower secondary (Grade 10 maximum)
- Group 6: Upper secondary (Grade 11 and above).

Note that many of the exhibits in this chapter present data in the form of estimated percentages based on weighted data; they also provide standard errors for these estimates. Note also that in this section of the chapter (dealing with the IPQ data), all of the results displayed in the exhibits and in the accompanying discussion must be considered with reference to a number of limitations on the data for particular countries. The limitations are as follows.

Limitation annotations for institution data

a. *Chinese Taipei:* exclusion rate was greater than five percent (see the TEDS-M technical report).

b. *Malaysia:* the participation rate was 57%, and the quality of the IPQ data was questionable.

c. *Norway:* Norwegian program-types are reported separately because the populations partly overlapped; data from these program-types cannot therefore be aggregated.

d. *Oman:* the only data provided at the time of testing were secondary teacher education data.

e. *Philippines:* the exclusion rate was greater than five percent (see the technical report).

f. *Poland:* institutions not included were those providing consecutive programs only.

g. *Russian Federation:* the secondary pedagogical institutions were not included.

h. *Spain:* only primary teacher education was covered.

i. *Switzerland:* the only institutions included were those where German is the primary language of use and instruction.

j. *United States:* only public institutions were covered.

Note: Data from Canada were unacceptable. Germany did not authorize reporting of the IPQ data. According to IEA standards, low participation rates are < 60%. For more information, see the TEDS-M technical report (Tatto, 2012).

4.2.2 Program-Groups

Exhibit 4.1 shows the estimated percentage of each type of program-group offered in each country at the primary and secondary school levels. In the case of Poland, for example, we estimated, on the basis of data from the 125 primary-level IPQs completed and submitted, that 71% of the teacher education programs at that level cater to future teachers who will be certified to teach up to Grade 4 only. The other 29% of programs are directed at future primary teachers training to work as primary mathematics specialists.

Relatively few countries prepare mathematics specialists at the primary level, and fewer still prepare teachers as upper-primary/lower-secondary generalists (able to teach up to Grade 10). Many secondary programs prepare teachers to teach school mathematics to Grade 11 and above. The three types of program-group most prevalent in the participating countries are primary generalist (Grade 6 maximum), lower-secondary specialist (Grade 10 maximum), and secondary (Grade 11 and above). Only four countries (Georgia, Poland, the Russian Federation, and Switzerland) offer primary generalist programs aimed at Grade 4 and below. Five—Malaysia, Poland, Singapore, Thailand, and the United States—prepare primary mathematics specialists. Malaysia and Thailand offer only primary specialist programs.

4.2.3 Program Entry Requirements

One indicator of program selectivity in mathematics teacher education is whether prospective teachers are required to have a specified level of qualification in order to enter the program of their choice. Exhibit 4.2 shows that most programs in almost every country require at least some upper-secondary school qualifications in mathematics. In general, entrance requirements are higher for those planning to teach upper-secondary school mathematics.

Some programs, notably those in Chinese Taipei and Singapore, are provided in post-secondary institutions (at ISCED Level 4 for the former country and ISCED Level 5 for the latter) for both future primary and secondary teachers. In Chinese Taipei, where admission to teacher education takes place after admission to university, future teachers must complete one year of university before being admitted to a teacher education program. In Singapore, the requirement is a special A-Level qualification, a polytechnic diploma, or a special post-secondary degree.

4.2.3.1 Future teachers' prior achievement in mathematics as a selection criterion

Another factor that influences future teachers' admission to a teacher education program is the extent to which institutions have admissions policies related to previous achievement levels in mathematics. Exhibit 4.3 shows, for each program-group in each country, the estimated percentage of programs using prior mathematics achievement as an entry criterion. For example, on the basis of the 86 IPQs submitted from Poland, we estimated that 90% of all teacher education programs in that country do not use prior achievement in mathematics as an entrance criterion. Eight percent of the IPQ respondents associated with these programs considered the criterion to be a "not very important" one, one percent considered it to be "somewhat important," and one percent rated it as a "very important" criterion.

Exhibit 4.1: Program-groups by country and by grade level (estimated percent)

Country	Program-Groups Primary									Program-Groups Secondary				
	Number of Programs Responding	*Lower Primary (to Grade 4 Maximum)*		*Primary (to Grade 6 Maximum)*		*Primary and Secondary Generalist (to Grade 10 Maximum)*		*Primary Mathematics Specialists*		Number of Programs Responding	*Lower Secondary (to Grade 10 Maximum)*		*Lower & Upper Secondary (to Grade 11 and above)*	
		Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*		Est.	*(SE)*	Est.	*(SE)*
Botswana	4					100.0	(0.0)			3	66.7	(23.6)	33.3	(23.6)
Chile[†]	31					100.0	(0.0)			38	100.0	(0.0)		
Chinese Taipei[a]	11			100.0	(0.0)					8			100.0	(0.0)
Georgia	10	100.0	(0.0)							7			100.0	(0.0)
Malaysia[b]	12							100.0	(0.0)	8			100.0	(0.0)
Norway (ALU)[†c]	16					100.0	(0.0)			16	100.0	(0.0)		
Norway (ALU+)[†c]	16					100.0	(0.0)			16	100.0	(0.0)		
Norway (PPU & Master's)[c]										11			100.0	(0.0)
Oman[d]										8			100.0	(0.0)
Philippines[e]	33			100.0	(0.0)					48	100.0	(0.0)		
Poland[†f]	125	71.0	(0.9)					29.0	(0.9)	39	53.8	(2.1)	46.2	(2.1)
Russian Federation[g]	45	100.0	(0.0)							43			100.0	(0.0)
Singapore	6			66.7	(23.6)			33.3	(23.6)	4	50.0	(35.4)	50.0	(35.4)
Spain[h]	48			100.0	(0.0)									
Switzerland[i]	21	33.3	(0.0)	66.7	(0.0)					7	100.0	(0.0)		
Thailand[†]	51							100.0	(0.0)	51			100.0	(0.0)
United States[†j]	71			82.3	(6.4)			17.7	(6.4)	61	21.0	(6.5)	79.0	(6.5)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see the TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated on page 96 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit 4.2: Minimum qualification required for entry to program (estimated percent)

Program-Group	Country	Number of Programs Responding	Percent of Programs in Response Categories (Weighted Estimates)							
			Lower Secondary (ISCED 2)		*Upper Secondary (ISCED 3)*		*Post-Secondary, Non-Tertiary (ISCED 4)*		*Degree (ISCED 5)*	
			Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	10			80.0	(14.1)	10.0	(10.0)	10.0	(10.0)
	Poland[f]	86			100.0	(0.0)				
	Russian Federation[g]	44			76.9	(15.7)	21.4	(15.9)	1.7	(1.8)
	Switzerland[i]	7			71.4	(17.5)	28.6	(17.5)		
Group 2. Primary to Grade 6 Maximum)	Chinese Taipei[a]	11			10.8	(3.8)			89.2	(3.8)
	Philippines[e]	33	1.7	(1.7)	85.5	(7.8)	1.9	(1.4)	11.0	(7.4)
	Singapore	4					75.0	(21.2)	25.0	(21.2)
	Spain[h]	48			100.0	(0.0)				
	Switzerland[i]	14			92.9	(7.1)	7.1	(7.1)		
	United States[j]	55			78.4	(5.7)			21.6	(5.7)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	4			75.0	(25.0)	25.0	(25.0)		
	Chile[†]	31	12.9	(7.2)	80.6	(7.2)	6.5	(4.6)		
	Norway (ALU)[†c]	16			93.8	(6.3)	6.3	(6.3)		
	Norway (ALU+)[†c]	14			100.0	(0.0)				
Group 4. Primary Mathematics Specialists	Malaysia[b]	12					8.3	(8.3)	91.7	(8.3)
	Poland[†f]	39			100.0	(0.0)				
	Singapore	2					50.0	(35.4)	50.0	(35.4)
	Thailand[†]	49			86.0	(3.5)			14.0	(3.5)
	United States[†j]	15			80.7	(5.9)			19.3	(5.9)

Exhibit 4.2: Minimum qualification required for entry to program (estimated percent) (contd.)

Program-Group	Country	Number of Programs Responding	Percent of Programs in Response Categories (Weighted Estimates)							
			Lower Secondary (ISCED 2)		*Upper Secondary (ISCED 3)*		*Post-Secondary, Non-Tertiary (ISCED 4)*		*Degree (ISCED 5)*	
			Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana	2			100.0	(0.0)				
	Chile[†]	38	13.3	(6.5)	74.5	(9.2)	8.5	(5.0)	3.7	(5.3)
	Norway (ALU)[†c]	16			93.8	(6.3)	6.3	(6.3)		
	Norway (ALU+)[†c]	14			100.0	(0.0)				
	Philippines[e]	48	1.0	(1.0)	93.1	(4.2)	0.7	(0.7)	5.2	(4.0)
	Poland[†f]	21			100.0	(0.0)				
	Singapore	2							100.0	(0.0)
	Switzerland[i]	7			100.0	(0.0)				
	United States[†j]	15			80.7	(5.9)			19.3	(5.9)
Group 6. Lower and Upper Secondary (to Grade 11 & above)	Botswana	1			100.0	(0.0)				
	Chinese Taipei[a]	8					100.0	(0.0)		
	Georgia	7			57.1	(10.1)			42.9	(10.1)
	Malaysia[b]	8					100.0	(0.0)		
	Norway (PPU & Master's)[c]	11			9.2	(13.1)			90.8	(13.1)
	Oman[d]	8	12.5	(12.5)	87.5	(12.5)				
	Poland[f]	18			100.0	(0.0)				
	Russian Federation[g]	43			98.6	(1.4)			1.4	(1.4)
	Singapore	2							100.0	(0.0)
	Thailand[†]	49			86.0	(3.5)			14.0	(3.5)
	United States[j]	44			77.8	(4.2)			22.2	(4.2)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see the TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated on page 96 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Prior mathematics achievement is an important criterion for admission to primary programs in Georgia, the Philippines, the Russian Federation, and Singapore. This was also the case for primary/secondary programs in Botswana, primary specialist programs in Malaysia and Singapore, lower-secondary programs in Botswana, the Philippines, Poland, Singapore, and the United States, and upper-secondary programs in Botswana, Chinese Taipei, Georgia, Malaysia, the Russian Federation, Singapore, Thailand, and the United States.

A related question in the IPQ asked respondents to state how well they thought future teachers entering the particular program rated with respect to their prior academic achievement and in reference to national norms. Exhibit 4.4 presents a summary of their responses. Respondents in most primary and secondary programs rated teachers as "above-average achievers for their age group." In Singapore and Oman, programs are able to recruit a substantial number of students (50% or more of total cohorts) whom respondents rated as being in the top 20% of their age group. Respondents in other countries, Chinese Taipei (primary) and Malaysia in particular, gave the same rating, but for lower percentages (30% or more of student cohorts).

Few teacher education programs reported recruiting students from the top 10% of their class in significant numbers. Respondents in many countries rated future teachers as average or below-average achievers in mathematics for their age group.

4.2.4 The Content of Teacher Education Programs

Participating institutions provided detailed information about the academic and professional content of their teacher education programs. This included information about the number of subject areas graduates would be qualified to teach (i.e., specialists versus generalists) and the number of hours of instruction allocated to each area.

One distinct pattern emerged in regard to specialization. While most programs prepare future primary teachers to teach more than two subjects, those catering for future secondary teachers prepare them, for the most part, to teach one or two subjects. For instance, most future teachers of lower- and upper-secondary schools in Chinese Taipei, Georgia, Oman, Poland, the Russian Federation, Thailand, and the United States are trained to teach only one subject. Exceptions to this pattern were found in countries with programs preparing teachers for both primary and secondary certification, as in Chile, Norway, and some programs in the United States (see Exhibit 2.1 in Chapter 2).

Exhibit 4.3: Importance of prior achievement in mathematics in the program admissions process (estimated percent)

Program-Group	Country	Number of Programs Responding	Percent of Programs in Response Categories (Weighted Estimates)							
			Not Considered		*Not Very Important*		*Somewhat Important*		*Very Important*	
			Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	10	10.0	(10.0)			80.0	(14.1)	10.0	(10.0)
	Poland[f]	86	89.5	(3.1)	8.1	(2.6)	1.2	(1.2)	1.2	(1.2)
	Russian Federation[g]	44	15.0	(6.6)	2.6	(2.0)	41.3	(9.6)	41.0	(8.5)
	Switzerland[i]	7	71.4	(24.7)			28.6	(24.7)		
Group 2. Primary to Grade 6 Maximum)	Chinese Taipei[a]	11	40.6	(24.0)	43.2	(25.7)	16.2	(6.5)		
	Philippines[e]	32	4.0	(3.0)	6.3	(6.6)	24.7	(9.7)	65.0	(12.2)
	Singapore	4					100.0	(0.0)		
	Spain[h]	46	95.3	(2.8)	3.1	(2.2)	1.6	(1.6)		
	Switzerland[i]	13	92.3	(7.7)	7.7	(7.7)				
	United States[j]	54	22.1	(6.1)	20.0	(3.6)	55.6	(6.8)	2.3	(1.3)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	4					75.0	(25.0)	25.0	(25.0)
	Chile[†]	28	85.7	(7.1)	7.1	(5.0)			7.1	(5.0)
	Norway (ALU)[†c]	13	46.2	(15.0)	15.4	(10.1)	38.5	(12.8)		
	Norway (ALU+)[†c]	14	35.7	(12.4)	21.4	(12.4)	42.9	(17.5)		
Group 4. Primary Mathematics Specialists	Malaysia[b]	12	8.3	(8.3)			58.3	(14.4)	33.3	(11.8)
	Poland[†f]	38	36.8	(8.2)	5.3	(3.8)	34.2	(8.4)	23.7	(7.4)
	Singapore	2					100.0	(0.0)		
	Thailand[†]	50	12.0	(4.5)	17.9	(6.0)	44.1	(7.5)	26.0	(6.5)
	United States[†j]	14	5.2	(5.8)	38.8	(34.8)	31.1	(18.1)	25.0	(22.5)

Exhibit 4.3: Importance of prior achievement in mathematics in the program admissions process (estimated percent) (contd.)

Program-Group	Country	Number of Programs Responding	Percent of Programs in Response Categories (Weighted Estimates)							
			Not Considered		*Not Very Important*		*Somewhat Important*		*Very Important*	
			Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana	2							100.0	(0.0)
	Chile†	34	89.3	(5.3)	5.3	(3.7)			5.3	(3.7)
	Norway (ALU)†c	13	46.2	(15.0)	15.4	(10.1)	38.5	(12.8)		
	Norway (ALU+)†c	14	35.7	(12.4)	21.4	(12.4)	42.9	(17.5)		
	Philippines[e]	48	0.9	(0.9)	7.7	(5.2)	26.7	(8.7)	64.7	(9.0)
	Poland†f	21	28.6	(11.8)	9.5	(7.1)	38.1	(13.0)	23.8	(10.1)
	Singapore	2							100.0	(0.0)
	Switzerland[i]	7	100.0	(0.0)						
	United States†j	14	5.2	(5.8)	38.8	(34.8)	31.1	(18.1)	25.0	(22.5)
Group 6. Lower and Upper Secondary (to Grade 11 & above)	Botswana	1							100.0	(0.0)
	Chinese Taipei[a]	8			4.8	(4.8)	81.0	(6.7)	14.3	(4.8)
	Georgia	7					42.9	(17.5)	57.1	(17.5)
	Malaysia[b]	8					12.5	(12.5)	87.5	(12.5)
	Norway (PPU & Master's)[c]	11	45.6	(17.0)	9.0	(9.0)	9.0	(9.0)	36.4	(17.0)
	Oman[d]	8	37.5	(12.5)	12.5	(12.5)	50.0	(0.0)		
	Poland[f]	17	47.1	(11.2)			29.4	(9.6)	23.5	(11.3)
	Russian Federation[g]	42	4.4	(3.2)	12.6	(6.5)	23.2	(7.8)	59.7	(7.0)
	Singapore	2							100.0	(0.0)
	Thailand†	50	12.0	(4.5)	17.9	(6.0)	44.1	(7.5)	26.0	(6.5)
	United States[j]	46	12.2	(4.4)	2.6	(1.6)	47.6	(10.5)	37.7	(10.1)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see the TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated on page 96 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit 4.4: Ratings of future teachers' prior achievement (estimated percent)

Program-Group	Country	Number of Programs Responding	Percent of Programs in Response Categories (Weighted Estimates)											
			Top 10 % of Age Group		*Top 20% of Age Group*		*Above-Average Achievers for Age Group*		*Average Achievers for Age Group*		*Below-Average Achievers for Age Group*		*Well-Below-Average Achievers for Age Group*	
			Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	10					20.0	(14.1)	70.0	(17.3)	10.0	(10.0)		
	Poland[f]	84	3.6	(2.1)	3.6	(2.1)	17.9	(4.6)	69.0	(5.5)	6.0	(2.6)		
	Russian Federation[g]	45			14.4	(6.4)	23.5	(8.6)	62.1	(10.7)				
	Switzerland[i]	5			20.0	(20.4)	80.0	(20.4)						
Group 2. Primary to Grade 6 Maximum)	Chinese Taipei[a]	11	5.4	(5.1)	37.8	(26.1)	46.0	(24.6)	10.8	(7.3)				
	Philippines[e]	33			13.7	(8.1)	48.1	(10.2)	38.1	(8.7)				
	Singapore	4			75.0	(21.2)	25.0	(21.2)						
	Spain[h]	47			2.5	(2.5)	18.6	(3.0)	60.9	(3.4)	16.6	(4.3)	1.4	(1.4)
	Switzerland[i]	13			23.1	(13.4)	46.2	(13.8)	23.1	(7.9)	7.7	(7.7)		
	United States[j]	56	6.4	(3.0)	14.7	(2.7)	50.2	(9.5)	28.7	(7.8)				
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	4	25.0	(25.0)			25.0	(25.0)	50.0	(0.0)				
	Chile[†]	30			3.3	(3.3)	33.3	(7.2)	43.3	(7.5)	20.0	(7.6)		
	Norway (ALU)[†c]	16			6.3	(6.3)	12.5	(8.8)	75.0	(12.5)	6.3	(6.3)		
	Norway (ALU+)[†c]	16			6.3	(6.3)	18.8	(6.3)	75.0	(0.0)				
Group 4. Primary Mathematics Specialists	Malaysia[b]	12	8.3	(8.3)	33.3	(16.7)	41.7	(18.6)	8.3	(8.3)			8.3	(8.3)
	Poland[†f]	39			2.6	(2.6)	46.2	(8.0)	46.2	(7.5)	5.1	(3.6)		
	Singapore	2			50.0	(35.4)	50.0	(35.4)						
	Thailand[†]	47	6.3	(4.2)	10.6	(4.4)	49.0	(8.1)	21.3	(6.1)	10.7	(4.8)	2.1	(2.1)
	United States[†j]	15	5.8	(6.6)	25.4	(19.1)	29.5	(18.2)	39.3	(32.8)				

Exhibit 4.4: Ratings of future teachers' prior achievement (estimated percent) (contd.)

Program-Group	Country	Number of Programs Responding	Percent of Programs in Response Categories (Weighted Estimates)											
			Top 10 % of Age Group		*Top 20% of Age Group*		*Above-Average Achievers for Age Group*		*Average Achievers for Age Group*		*Below-Average Achievers for Age Group*		*Well-Below-Average Achievers for Age Group*	
			Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana	2					100.0	(0.0)						
	Chile[†]	36			6.5	(3.5)	33.3	(8.0)	44.9	(8.2)	15.2	(5.9)		
	Norway (ALU)[†c]	16			6.3	(6.3)	12.5	(8.8)	75.0	(12.5)	6.3	(6.3)		
	Norway (ALU+)[†c]	16			6.3	(6.3)	18.8	(6.3)	75.0	(0.0)				
	Philippines[e]	48			9.0	(5.3)	63.8	(8.2)	22.0	(7.0)	5.3	(3.7)		
	Poland[†f]	21					28.6	(11.3)	61.9	(11.1)	9.5	(6.8)		
	Singapore	2			100.0	(0.0)								
	Switzerland[i]	6					83.3	(17.1)	16.7	(17.1)				
	United States[†j]	15	5.8	(6.6)	25.4	(19.1)	29.5	(18.2)	39.3	(32.8)				
Group 6. Lower and Upper Secondary (to Grade 11 & above)	Botswana	1							100.0	(0.0)				
	Chinese Taipei[a]	8	4.8	(4.8)			90.5	(6.7)	4.8	(4.8)				
	Georgia	7			28.6	(0.0)	42.9	(10.1)	28.6	(10.1)				
	Malaysia[b]	8			12.5	(12.5)	87.5	(12.5)						
	Norway (PPU & Master's)[c]	8			12.7	(10.6)	49.6	(16.2)	37.7	(21.6)				
	Oman[d]	8	37.5	(12.5)	50.0	(17.7)	12.5	(12.5)						
	Poland[f]	18			5.6	(5.6)	66.7	(11.4)	27.8	(9.8)				
	Russian Federation[g]	43			15.9	(7.5)	43.9	(9.4)	40.2	(8.7)				
	Singapore	2			100.0	(0.0)								
	Thailand[†]	47	6.3	(4.2)	10.6	(4.4)	49.0	(8.1)	21.3	(6.1)	10.7	(4.8)	2.1	(2.1)
	United States[j]	44	6.4	(2.1)	22.1	(7.3)	48.3	(10.7)	23.2	(10.3)				

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see the TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated on page 96 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Examination of the data on the relative emphasis that institutions give to specific areas of their teacher education programs—as indicated by the number of hours allocated to each—revealed that programs generally offer courses in four areas: (a) liberal arts, (b) mathematics and related content (academic mathematics, school mathematics, mathematics pedagogy), (c) educational foundations, and (d) pedagogy.[1]

Strong emphasis was defined as the allocation of 500 or more class hours over the duration of the program to a particular area. Exhibits A4.1 and A4.2 in Appendix A summarize the mean number of teaching contact hours in liberal arts, academic mathematics, and school mathematics curriculum courses. Exhibits A4.3 and A4.4 (also in Appendix A) present the mean number of teaching-contact hours in mathematics pedagogy, foundations, and general pedagogy courses by country and by program-group.

Overall, the IPQ responses revealed programs giving greater emphasis to academic and school curriculum mathematics if their future teachers intended to teach mathematics as specialists. This trend was particularly marked if the future teachers were those intending to teach in secondary school. A high degree of variability across countries was found in other content areas, including mathematics pedagogy and general pedagogy.

4.2.4.1 Liberal arts courses

Programs reporting strong emphasis on the liberal arts were found in Georgia, the Russian Federation in Program-Group 1, Spain in Program-Group 2, and Chile in Program-Group 3. Switzerland in Program-Group 1 and the United States in Program-Group 2 came close to the cutoff point. On average, the two countries were allocating 493 and 492 hours respectively to liberal arts. The primary-specialist program-groups had no means higher than 500. Of the secondary-level program-groups, those in Chile (1,393 hours) and Switzerland (832 hours) in Program-Group 5 and Botswana (630

1 Definitions of areas*

- *Liberal arts courses (except mathematics):* theoretical or general courses designed to develop an understanding of the natural and social sciences, the humanities, languages, drama, music, art, philosophy, and religion, among others. In general these courses do not address professional curricula.
- *Academic mathematics courses:* courses that aim to provide mathematics knowledge to a population of university students that may or may not include future teachers, and are designed to treat content beyond the mathematics learned at the secondary school level, that is, mathematics at the university level (e.g., abstract algebra, functional analysis, differential equations, etc.).
- *Mathematics content related to the school mathematics curriculum courses:* these deal mainly with the structure, sequence, content, and level of competence required for students to successfully learn from the school mathematics curriculum (primary or secondary levels). Examples of such courses are "structure and content of the lower-secondary mathematics curriculum," and "development and understanding of the school mathematics curriculum."
- *Mathematics pedagogy courses:* courses dealing with the methods of teaching and learning mathematics (e.g., mathematics pedagogy, didactics of mathematics). These courses might include content on learner cognition (e.g., how one learns mathematics) or learners' thinking in relation to mathematics concepts. Examples of such types of courses include "learner diversity" and the "teaching of mathematics," and the "teaching of primary and middle-school mathematics."
- *Professional foundations and theory courses:* these include the study of education, in terms of such disciplines as history, philosophy, sociology, psychology, social psychology, anthropology, economics, and political science. They also include interdisciplinary fields, such as comparative and international education, multicultural education, and community and adult education, along with many others.
- *General pedagogy courses:* courses on the art or science of teaching with a focus on the proper use of teaching strategies. Such courses also include the study of associations between teaching strategies, the instructor's own philosophical beliefs of teaching, and school-students' background knowledge and experiences, personal situations, and the social and classroom environment. Another facet of these courses involves preparation on setting learning goals.

Source: **Merriam-Webster Dictionary*: http://www.merriam-webster.com/dictionary/liberal%20arts hours) and the Russian Federation (1,468 hours) in Group 6 were dedicating more than 500 hours to courses in the liberal arts. The United States mean, at 499 hours, was very close to the cutoff point. Many programs across countries were in the 100 to 500 hours range.

4.2.4.2 Academic mathematics

Among the four primary program-groups, only the Russian Federation in Group 1 and Poland in Group 4 (primary mathematics specialists) were allocating an average of more than 400 teaching hours to academic mathematics. Thailand in Group 4 was allocating more than 300 hours, while Georgia (Group 1), Singapore (Group 2), and Chile and Norway (Group 3) were allocating an average of more than 200 contact hours to academic mathematics. Programs in the other countries had averages of fewer than 200 hours.

In Program-Group 5, which included programs preparing future teachers to teach lower-secondary school up to Grade 10, the emphasis on academic mathematics ranged from no hours in Singapore to an average of 292 hours in Switzerland. The exception was Poland, which reported an average of 666 hours of academic mathematics. In Program-Group 6, which included programs preparing teachers for lower- and upper-secondary schools, there was a greater emphasis on academic mathematics, with programs in Botswana, Chinese Taipei, Georgia, Malaysia, and Oman allocating, on average, over 500 hours to that area. Poland and the Russian Federation were allocating an average of 1,310 and 1,857 hours, respectively. The lowest average time allocations for academic mathematics in Program-Group 5 were evident in Norway PPU and Master's (134 hours), Thailand (343 hours), and the United States (442 hours).

4.2.4.3 Mathematics content related to the school mathematics curriculum

Most of the four primary program-groups reported spending, on average, fewer than 100 contact hours in this area, with the exception of Georgia and the Russian Federation in Group 1, Chile and Norway in Group 3, and Malaysia and Thailand in Group 4. These programs reported providing more than 100 but fewer than 400 contact hours in this area. Only the Russian Federation and Norway (PPU and Master's) were allocating, on average, more than 350 teaching contact hours to mathematics content related to the school mathematics curriculum.

In the lower-secondary group, Group 5, the emphasis given to school mathematics was low in the Philippines, Poland, Singapore, Switzerland, and the United States. All five countries reported averages of fewer than 100 contact hours. Only programs in Botswana and Chile averaged more than 100 hours; Norway was allocating more than 350 hours in its ALU and ALU plus mathematics programs. The only country allocating more than 400 hours to this area in its lower- and upper-secondary program (Program-Group 6) was Botswana, followed closely by the Russian Federation, with 380 hours. Chinese Taipei, Poland, Singapore, and the United States were all allocating fewer than 100 hours to this area.

4.2.4.4 Mathematics pedagogy

All of the programs in primary Program-Groups 1 to 4, except those in Norway and the Russian Federation, reported spending fewer than 200 teaching-contact hours on mathematics pedagogy. A number of countries in Program-Groups 1 and 2 reported very low averages: Poland (37) and Switzerland (98) in Group 1, and Chinese Taipei

(22), the Philippines (58), Switzerland (76), and the United States (63) in Program-Group 2. The average number of hours in this area was greater than 100 in Program-Groups 3 and 4, with the exception of programs in the United States, which reported an average of 52 hours in Program-Group 4.

In the lower-secondary program-group, Group 5, the means ranged from as low as 52 hours in the United States to 163 in Switzerland; only programs in Norway were allocating more than 300 hours to this area. In Program-Group 6, containing programs that prepare future teachers to teach lower- and upper-secondary classes to Grade 11 and above, only Botswana and the Russian Federation reported allocating more than 200 hours to this area of study. For most other countries, the average number of hours reported ranged from 100 to 138. However, Chinese Taipei and the United States reported the lowest mean contact hours—95 and 72, respectively.

4.2.4.5 Foundations courses

Most of the primary program-groups were allocating at least 100 teaching hours to this area. Means greater than 400 were found in Poland, the Russian Federation, and Switzerland in Group 1, in Switzerland in Group 2, and in Chile in Group 3. The Philippines and Singapore in Group 2 and Poland, Singapore, and the United States in Group 4 were all allocating fewer than 100 hours to foundations courses.

We found considerable cross-national variation with respect to foundations courses in the secondary program-groups. In Program-Group 5, Botswana, the Philippines, Poland, Singapore, and the United States were allocating fewer than 100 hours to this area. The rest were allocating more than 100 contact hours to the study of foundations, with Switzerland and Norway showing means ranging from close to 200 to close to 300 contact hours. The exception in this program-group was Chile, which was allocating more than 500 contact hours to this area. In Program-Group 6, a large number of countries were allocating more than 100 hours, but fewer than 400. The Russian Federation in Group 6 was allocating more than 600 hours. In Program-Group 6, Poland and Singapore were allocating fewer than 100 hours.

4.2.4.6 General pedagogy courses

Primary program-groups reported devoting a substantial number of hours to general pedagogy. Only five programs reported allocating fewer than 100 hours to this area. They were the Philippines and Singapore in Group 2, Botswana in Group 3, and Poland and Singapore in Group 4. The Russian Federation and Switzerland in Group 1 and Chile in Group 3 reported very high coverage—more than 500 hours.

Of the countries offering lower-secondary programs (Group 5), Botswana, the Philippines, Poland, and Singapore reported allocating fewer than 100 hours to foundations courses. Chile reported allocating more than 700. In Group 6, most countries reported allocating more than 100 hours. The countries that said they allocated fewer than 100 hours were Botswana, Poland, and Singapore.

4.2.4.7 Field experiences

For the purposes of TEDS-M, field experience was defined as follows:

- *Extended teaching practice*, with two weeks or more of continuous work in schools when the main purpose is to prepare and enable future teachers to assume overall responsibility for teaching a class or classes of students; or as
- *Introductory field experiences*, for short-term assignments in primary and secondary schools for various exploratory and preparatory purposes, such as getting to know schools as organizations and how they work, learning about the work of teachers and whether they find it an appropriate choice of career, observing and interviewing students, teachers, and parents, and assisting in teaching tasks in limited and closely supervised ways.

Although most programs were providing *extended teaching practice*, we found a high degree of variation in the percentages of programs within and across countries providing *introductory field experiences*, at both the primary and the secondary school levels (see Exhibit 4.5). Among the primary program-groups, the percentage of programs providing extended field experience was generally high (over 80%). Countries where more than 50% but fewer than 80% percent of programs reported offering introductory field experiences at primary school level included Georgia, Poland, the Russian Federation, and Switzerland in Group 1, Singapore and Switzerland in Group 2, and Botswana and Norway in Group 3. In Spain, however, only 25% of programs were offering these experiences. Among the primary specialists, all were close to or above the 80% mark.

Among secondary programs, 75% or more of the Group 5 programs in Chile, the Philippines, Poland, and the United States were offering extended field experiences. This was also the case for Group 6 programs in Botswana, Chinese Taipei, Malaysia, Poland, the Russian Federation, Thailand, and the United States. The extent to which the remaining programs (in their respective countries) were offering these experiences varied widely, with the range spanning 0 to 49%.

4.2.5 Graduation Standards and Guidelines

Institutions were asked to specify what requirements future teachers had to meet in order to successfully complete their programs, and whether the institutions as well as agencies at national and state levels set prescribed competencies or standards. The findings are displayed in four exhibits in Appendix A—Exhibits A4.5 and A4.6 for programs at the primary level and Exhibits A4.7 and A4.8 for those at the secondary level.

The data show that nearly all programs at the primary level across countries require their future teachers to have passing grades in all courses in order to graduate. The same applies to the student-teachers' field experience. Here, graduation relies on demonstrating an acceptable level of teaching competence in a classroom. A comprehensive examination of some kind, whether written or oral, is also a common requirement across institutions. A less frequent requirement is a thesis. The countries that reported this requirement for most or all of their primary programs were Poland, the Russian Federation, and Switzerland (Program-Group 1), the Philippines and Switzerland (Program-Group 2), Botswana (two out of four programs), Chile (most Group 3 programs), and Poland (many programs in Group 4). Writing and defending a thesis is a more frequent requirement in secondary Program-Groups 5 and 6. The countries where this was not the case were Chinese Taipei, Singapore, Norway (PPU and Master's), and the United States.

Exhibit 4.5: Field experiences offered in teacher education programs (estimated percent)

Program-Group	Country	Extended Teaching Practice			Introductory Field Experience		
		n	Est.	*(SE)*	*n*	Est.	*(SE)*
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	9	100.0	(0.0)	8	75.0	(15.3)
	Poland[f]	86	93.0	(1.6)	86	67.4	(5.5)
	Russian Federation[g]	45	100.0	(0.0)	42	76.2	(16.5)
	Switzerland[i]	7	100.0	(0.0)	7	71.4	(17.5)
Group 2. Primary to Grade 6 Maximum)	Chinese Taipei[a]	11	100.0	(0.0)	11	94.6	(5.1)
	Philippines[e]	30	84.5	(10.6)	30	96.7	(2.5)
	Singapore	4	100.0	(0.0)	4	50.0	(23.6)
	Spain[h]	48	100.0	(0.0)	39	24.7	(4.7)
	Switzerland[i]	14	100.0	(0.0)	14	78.6	(7.1)
	United States[j]	54	100.0	(0.0)	53	100.0	(0.0)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	4	100.0	(0.0)	4	50.0	(35.4)
	Chile[†]	30	96.7	(3.3)	28	96.4	(3.6)
	Norway (ALU)[†c]	16	100.0	(0.0)	15	73.3	(13.0)
	Norway (ALU+)[†c]	16	100.0	(0.0)	16	62.5	(12.5)
Group 4. Primary Mathematics Specialists	Malaysia[b]	9	66.7	(7.4)	11	90.9	(9.2)
	Poland[†f]	39	100.0	(0.0)	39	79.5	(6.4)
	Singapore	2	100.0	(0.0)	2	0.0	(0.0)
	Thailand[†]	48	100.0	(0.0)	49	100.0	(0.0)
	United States[†j]	15	100.0	(0.0)	15	93.2	(7.8)
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana	2	100.0	(0.0)	2	50.0	(55.6)
	Chile[†]	37	97.6	(2.4)	35	97.4	(2.6)
	Norway (ALU)[†c]	16	100.0	(0.0)	15	73.3	(13.0)
	Norway (ALU+)[†c]	16	100.0	(0.0)	16	62.5	(12.5)
	Philippines[e]	43	90.0	(6.4)	40	94.6	(2.3)
	Poland[†f]	21	100.0	(0.0)	21	76.2	(8.3)
	Singapore	2	100.0	(0.0)	2	0.0	(0.0)
	Switzerland[i]	6	100.0	(0.0)	7	71.4	(20.2)
	United States[†j]	15	100.0	(0.0)	15	93.2	(7.8)
Group 6. Lower and Upper Secondary (to Grade 11 & above)	Botswana	1	100.0	(0.0)	1	100.0	(0.0)
	Chinese Taipei[a]	8	100.0	(0.0)	8	100.0	(0.0)
	Georgia	6	100.0	(0.0)	6	0.0	(0.0)
	Malaysia[b]	8	100.0	(0.0)	8	100.0	(0.0)
	Norway (PPU & Master's)[c]	11	63.1	(13.1)	11	17.9	(12.7)
	Oman[d]	8	87.5	(12.5)	6	33.3	(19.8)
	Poland[f]	18	100.0	(0.0)	18	83.3	(9.7)
	Russian Federation[g]	42	100.0	(0.0)	41	75.6	(5.5)
	Singapore	2	100.0	(0.0)	2	0.0	(0.0)
	Thailand[†]	48	100.0	(0.0)	49	100.0	(0.0)
	United States[j]	44	98.2	(1.9)	44	100.0	(0.0)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see the TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated on page 96 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in the list of limitations, cannot be compared with confidence to data from other countries.

4.2.5.1 Origins of policy guidelines

Most of the guidelines regarding competencies or standards for graduation across the program-groups originate with the state or provincial government, the institution where the program is located, or a combination of both. Table A4.9 in Appendix A summarizes information about where the locus of control of standards for teacher education resides in the participating countries.

The state government has relatively more control in Botswana, Chile, and Thailand, while the institutions seem to have more control in Chinese Taipei, Malaysia, and the Russian Federation. In other countries, institutions share the responsibility for setting performance standards with their governments to varying degrees, as evident in Georgia, Poland, the Philippines, Spain, Norway, and Oman. In the United States, much of the responsibility resides with state and federal governments.

4.3 Teacher Educator Background and Characteristics

Teacher educators were defined as persons with regular, repeated responsibility for teaching future teachers within a teacher-preparation program. (For more detail on definitions see Tatto et al., 2008.) Within the context of TEDS-M, teacher educators were classified into three groups, as follows:

A. *Mathematics and mathematics pedagogy educators:* those responsible for teaching one or more required courses in mathematics or mathematics pedagogy during the TEDS-M data collection year at any stage of the teacher preparation program;
B. *General pedagogy educators:* those responsible for teaching one or more required courses in foundations or general pedagogy (other than a mathematics or mathematics pedagogy course) during the data collection year at any stage of the teacher preparation program; and
C. *Educators belonging to both of the above groups:* those responsible for teaching one or more required courses in mathematics, mathematics pedagogy, or general pedagogy during the data collection year at any stage of the teacher preparation program.

The results displayed in the exhibits in this section of the chapter and discussed in the accompanying text must be considered in the light of a number of limitations on the data for particular countries, set out in the following panel.

Limitation annotations for teacher educator data

a. *Chile:* the combined participation rate was 54%.
b. *Germany:* the combined participation rate was 56%; the surveys of institutions and future teachers have no connection with the survey of educators.
c. *Malaysia:* the combined participation rate was 57%.
d. *Oman:* the only data provided at the time of testing were secondary teacher education data.
e. *Poland:* the combined participation rate was between 60 and 75%; institutions with consecutive programs only were not covered.
f. *Russian Federation:* the secondary pedagogical institutions were not covered.
g. *Spain:* only primary teacher education was covered.
h. *Switzerland:* the combined participation rate was 52%. The only institutions covered were those where German is the primary language of use and instruction.

Note: Data from Canada, Norway, and the United States were deemed unacceptable. According to IEA standards, low participation rates are <60%. For more information, see the TEDS-M technical report (Tatto, 2012).

4.3.1 Teacher Educator Samples

Exhibit B.6 in Appendix B shows the makeup of the TEDS-M teacher educator sample. It included 7,398 teacher educators, of whom 5,190 provided usable data. The exhibit also shows how the teacher educators were distributed across countries. The teacher educator response rate was the lowest among the various TEDS-M surveys. Because of this, the TEDS-M research team considered that only 10 of the participating countries had data sufficiently reliable to be reported. The excluded countries were Canada, Norway, and the United States (combined participation rates below 30%). The data for Chile, Germany, and Malaysia are shaded in the following exhibits in order to highlight the increased likelihood of bias due to low response rates. (For more detail on sampling, see Tatto, 2012.)

4.3.1.1 Distribution of teacher educators by discipline taught

It was not possible to draw separate samples for teacher educators teaching primary programs and those teaching secondary programs because teacher educators commonly teach across levels and, in some cases, across disciplines. Exhibit 4.6 shows the distribution of educators by country and by discipline. The three discipline-based categories used were those stated earlier in this chapter—mathematics and mathematics pedagogy (Category A), general pedagogy (Category B), and both preceding categories combined (Category C).

Of the total teacher-educator sample, the smallest proportion included teacher educators teaching in both main areas, A and B. The rest of the sample was distributed between the two other groups: those teaching mathematics or mathematics pedagogy courses, and those teaching general pedagogy. Certain patterns are worth noticing. In Georgia, Oman, Poland, and the Russian Federation, a majority of teacher educators were teaching only mathematics or mathematics pedagogy courses.

Exhibit 4.6: Disciplines taught by teacher educators (estimated percent)

Country	*n*	A. Mathematics and Mathematics Pedagogy		B. General Pedagogy		C. Both Areas A and B	
		Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Botswana	43	36.4	(0.0)	63.6	(0.0)	0.0	(0.0)
Chile[a]	392	18.0	(0.3)	58.8	(0.6)	23.1	(0.7)
Chinese Taipei	195	40.4	(4.1)	59.0	(4.1)	0.6	(0.2)
Georgia	62	65.6	(1.8)	31.3	(0.3)	3.1	(2.2)
Germany[b]	482	12.1	(3.2)	62.0	(5.9)	25.9	(4.6)
Malaysia[c]	255	59.1	(0.1)	13.4	(0.0)	27.5	(0.1)
Oman[d]	84	62.1	(0.1)	35.9	(0.1)	1.9	(0.0)
Philippines	589	29.5	(3.0)	46.0	(5.9)	24.5	(5.4)
Poland[e]	734	64.9	(0.3)	32.7	(0.2)	2.4	(0.1)
Russian Federation[f]	1,212	76.7	(2.4)	20.6	(1.9)	2.7	(0.9)
Singapore	77	33.0	(0.0)	67.0	(0.0)	0.0	(0.0)
Spain[g]	533	20.8	(0.7)	76.1	(2.2)	3.1	(2.4)
Switzerland[h]	220	18.5	(0.5)	81.3	(0.4)	0.2	(0.2)
Thailand	312	39.0	(0.1)	36.3	(0.1)	24.8	(0.1)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

In contrast, in Botswana, Chile, Chinese Taipei, Germany, Singapore, Spain, and Switzerland, a large proportion of the teacher educators were teaching only general pedagogy courses. In the Philippines and Thailand, teacher educators were more evenly distributed across the three groups.

4.3.1.2 *Gender of teacher educators*

Exhibit 4.7 shows the gender distribution of teacher educators by country and by courses taught. Of those teaching mathematics or mathematics pedagogy courses, 60% or more were males in Chinese Taipei, Georgia, Germany, Oman, Singapore, and Switzerland. More females than males were teaching pedagogy in the majority of countries. The exceptions were Oman, Chinese Taipei, Malaysia, and Switzerland. Of the comparatively few educators with teaching responsibilities in both main areas (i.e., educators teaching mathematics, mathematics pedagogy, and general pedagogy), 50% or more were females, except in Chile, Germany, and Switzerland.

Exhibit 4.7: Gender of teacher educators by disciplines taught (estimated percent female)

Country	A. Mathematics and Mathematics Pedagogy Teacher Educators			B. General Pedagogy Teacher Educators			Teacher Educators of Both Areas A. and B.		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	16	43.8	(14.0)	27	58.9	(9.9)			
Chile[a]	82	55.4	(4.6)	245	49.7	(3.0)	54	47.1	(8.3)
Chinese Taipei	81	23.5	(8.1)	103	41.4	(5.3)	2	50.0	(55.6)
Georgia	41	38.1	(7.4)	20	85.0	(8.7)	1	100.0	(0.0)
Germany[b]	109	15.6	(3.7)	219	60.7	(4.1)	140	42.3	(11.8)
Malaysia[c]	163	51.8	(4.2)	21	25.3	(6.9)	68	50.4	(6.2)
Oman[d]	50	5.4	(2.9)	28			2	100.0	(0.0)
Philippines	193	53.9	(4.8)	277	74.5	(6.2)	116	71.3	(5.5)
Poland[e]	449	40.9	(2.9)	248	78.2	(2.9)	24	80.0	(9.4)
Russian Federation[f]	894	70.1	(2.1)	270	84.9	(2.8)	17	98.4	(1.7)
Singapore	25	32.0	(6.9)	52	63.5	(6.4)			
Spain[g]	120	45.6	(5.8)	400	55.8	(2.0)	13	70.7	(4.4)
Switzerland[h]	48	33.3	(5.8)	157	37.5	(2.5)	1	0.0	(0.0)
Thailand	121	53.6	(4.9)	115	48.2	(4.8)	73	53.3	(6.4)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

4.3.2 Academic and Professional Qualifications of Teacher Educators

Teacher educators were asked to provide information about their academic and professional qualifications, their academic rank, and their area of specialization. There was particular interest in determining the extent of their backgrounds in mathematics, mathematics education, and education. The educators' responses are summarized in Exhibits A4.10, A4.11, and A4.12, in Appendix A.

4.3.2.1 Qualifications in mathematics

A large proportion (60% or more) of the mathematics and mathematics pedagogy educators in Chinese Taipei, Georgia, Germany, Oman, and Poland held doctoral degrees in mathematics. In the other countries, fewer than half of the educators held doctoral degrees. Among the teacher educators teaching in the general pedagogy area, only small proportions reported having a post-graduate degree in mathematics. Teacher educators teaching in both main areas reported relatively low proportions of doctoral-level qualifications in mathematics. The highest proportions of Master's degrees (close to 69% and 58%, respectively) were found among mathematics and mathematics pedagogy educators in Spain and Botswana. They were followed by the Russian Federation, Thailand, and the Philippines (with close to 53, 52, and 43%, respectively).

4.3.2.2 Qualifications in mathematics education

Exhibit A4.11 in Appendix A shows the proportions of educators whose highest degree was in the field of mathematics education. Over 80% of the mathematics and mathematics pedagogy educators in Botswana, followed by those in the Philippines and Singapore, held a Master's degree in one of these fields. Among the mathematics and mathematics pedagogy educators, fewer than 50% in all cases held a doctoral degree in mathematics education, with the highest proportion being in Georgia (42%). The range in the other countries was 6 to 31%. In Spain, the Russian Federation, Singapore, and Chinese Taipei, the percentages of teacher educators who were teaching mathematics and mathematics pedagogy and who had a doctoral degree in mathematics education ranged from 23.9 to 31%. A small proportion of teacher educators who were teaching in the general pedagogy area reported having a doctoral degree in mathematics education. The only countries in which more than 20% of the teacher educators who were teaching in both main areas held a doctoral degree in mathematics education were the Russian Federation and Thailand.

4.3.2.3 Qualifications in education

Exhibit A4.12 shows the highest degree that teacher educators earned in the field of education. Botswana, Chile, and the Russian Federation had the highest proportions of mathematics and mathematics educators (about 50%) with Master's degrees in education. A significant proportion of general pedagogy teacher educators in Botswana (close to 90%) and Thailand (close to 68%) had a Master's degree in education. The highest proportions of educators who had teaching responsibilities in both main areas and possessed a Master's degree in education were found in Thailand (50.2%), Malaysia (50%), Chile (close to 49%), and the Philippines (48.5%).

A minority (18% or fewer) of mathematics and mathematics pedagogy educators in Chinese Taipei, Georgia, Oman, the Philippines, Poland, and Spain held doctoral degrees in education. Of the general pedagogy teacher educators in Chinese Taipei, Georgia, Oman, Poland, and the Russian Federation, more than 60% had doctoral degrees in education.

4.3.2.4 Specialization in mathematics

As can be seen in Exhibit 4.8, most of the teacher educators teaching courses in mathematics and mathematics pedagogy considered mathematics to be their main specialty. The highest percentages were found in Botswana, Georgia, Germany, Oman, Poland, Singapore, Switzerland, and Thailand.

Of those teacher educators who were teaching general pedagogy, the majority reported that mathematics was not their specialty. The proportions of teacher educators with teaching responsibilities in both main areas and who indicated that mathematics was their specialty were relatively low across the countries. The highest proportions were found mainly in Germany (64%) and Thailand (48%).

Exhibit 4.8: Teacher educators rating mathematics as their "main specialty" by disciplines taught (estimated percent)

Country	A. Mathematics and Mathematics Pedagogy Teacher Educators			B. General Pedagogy Teacher Educators			Teacher Educators of Both Areas A. and B.		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	16	75.0	(10.8)	26	3.7	(2.6)			
Chile[a]	81	56.5	(5.4)	248	0.4	(0.4)	57	13.3	(4.1)
Chinese Taipei	84	51.9	(3.7)	107	0.0	(0.0)	2	0.0	(0.0)
Georgia	40	85.4	(4.5)	16	6.3	(6.3)	1	0.0	(0.0)
Germany[b]	114	94.5	(1.7)	224	1.0	(0.7)	140	63.6	(5.2)
Malaysia[c]	162	45.7	(4.0)	21	2.2	(2.2)	68	21.1	(3.9)
Oman[d]	50	90.6	(4.1)	29	6.8	(4.2)	2	100.0	(0.0)
Philippines	194	51.1	(5.7)	271	5.3	(2.4)	116	17.1	(6.9)
Poland[e]	452	73.7	(1.8)	252	0.7	(0.4)	22	36.6	(8.6)
Russian Federation[f]	904	58.5	(2.3)	268	1.8	(0.8)	17	18.3	(17.2)
Singapore	25	72.0	(8.9)	52	1.9	(1.9)			
Spain[g]	119	63.6	(5.8)	398	0.0	(0.0)	13	12.0	(16.2)
Switzerland[h]	51	75.8	(6.0)	167	0.7	(0.7)	1	100.0	(0.0)
Thailand	119	69.9	(3.6)	115	7.1	(2.5)	74	48.3	(4.9)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

4.3.2.5 License to teach in primary or secondary schools

Teacher educators were asked whether they currently held, or had ever held, a license to teach in primary or secondary school. Their responses are summarized in Exhibit 4.9.

The exhibit shows the proportions of those who answered, "Yes, I currently hold a license." More than 80% of the mathematics and mathematics pedagogy educators from Botswana, Chile, Georgia, Malaysia, the Russian Federation, Singapore, Spain, and Switzerland held teaching certificates. However, 30% or fewer of the mathematics and mathematics pedagogy teacher educators in Chinese Taipei, Germany, Oman, and Thailand held one. Among the educators who were teaching general pedagogy courses, 70% or more of them in nine countries said they held teaching certificates. The countries were Botswana, Chile, Georgia, Germany, Malaysia, the Philippines, the Russian Federation, Spain, and Switzerland. Lower proportions of this group of

Exhibit 4.9: Teacher educators who hold teaching certification by disciplines taught (estimated percent)

Country	A. Mathematics and Mathematics Pedagogy Teacher Educators			B. General Pedagogy Teacher Educators			Teacher Educators of Both Areas A. and B.		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	16	93.8	(6.3)	26	77.8	(7.9)			
Chile[a]	82	94.0	(2.4)	247	82.8	(2.3)	55	93.2	(3.6)
Chinese Taipei	85	29.4	(12.2)	107	45.7	(2.6)	2	50.0	(55.6)
Georgia	40	97.6	(2.4)	20	95.0	(5.0)	1	100.0	(0.0)
Germany[b]	114	11.6	(3.8)	225	89.1	(4.5)	141	90.8	(3.1)
Malaysia[c]	163	90.6	(1.9)	21	78.8	(14.1)	68	58.3	(5.6)
Oman[d]	47	22.3	(6.2)	28	57.6	(9.0)	2	100.0	(0.0)
Philippines	194	69.8	(5.2)	275	69.9	(4.8)	116	80.3	(7.5)
Poland[e]	444	67.0	(2.4)	252	54.9	(2.5)	24	82.2	(6.1)
Russian Federation[f]	912	83.6	(2.0)	275	98.1	(0.9)	17	100.0	(0.0)
Singapore	25	84.0	(5.7)	51	64.7	(6.8)			
Spain[g]	119	93.0	(2.4)	394	75.2	(3.3)	13	70.7	(4.4)
Switzerland[h]	48	96.3	(2.6)	162	89.2	(2.5)	1	100.0	(0.0)
Thailand	119	30.3	(4.2)	111	29.2	(4.5)	72	32.4	(5.8)

Notes:

1. When reading this table, keep in mind the limitations annotated on page 111 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

educators held certificates in Chinese Taipei (close to 46%), Poland (close to 55%), and Singapore (close to 65%). Of those educators with teaching responsibilities in both main areas, large percentages in Chile, Germany, the Philippines, the Russian Federation, and Poland reported holding teaching licenses.

4.4 Future Teachers' Backgrounds and Characteristics

As stated earlier in this report, future teachers were defined as students enrolled in teacher education programs designed to prepare them to teach mathematics at the primary or lower-secondary school levels. (For more detail on definitions, see Tatto et al., 2008.) TEDS-M found that most lower-secondary teacher education programs also prepare teachers for upper secondary; this is the group called Program-Group 6 throughout this report. Exhibits B.4 and B.5 in Appendix B provide details about the composition of the TEDS-M sample of future teachers and how they were distributed across the participating countries. Valid data were obtained from 13,871 future primary teachers and 8,207 future secondary teachers. (For more detail on sampling, see Tatto, 2012.)

In this section of the chapter, all of the results displayed in the exhibits and in the accompanying discussion must be read with reference to a number of limitations on the data from particular countries. These limitations are listed below in two parts. The first pertains to the future primary teacher data, and the second to the future lower-secondary teacher data.

Limitation annotations for future primary teacher data

a. *Botswana:* the sample size was small ($n = 86$), but it arose from a census of a small population.
b. *Chile:* combined participation rate was between 60 and 75%.
c. *Norway:* the combined participation rate was between 60 and 75%. An exception was made to accept data from one institution because one additional participant would have brought the response rate to above the 50% threshold. Program types ALU and ALU plus mathematics are reported separately because the two populations partly overlap; data from these program types cannot therefore be aggregated.
d. *Poland:* the combined participation rate was between 60 and 75%. The institutions not covered were those providing consecutive programs only.
e. *Russian Federation:* the secondary pedagogical institutions were not covered.
f. *Switzerland:* the only institutions covered were those where German is the primary language of use and instruction.
g. *United States:* only public institutions were covered. The combined participation rate was 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. Although the participation rate for the complete sample met the required standard, the data contain records that were collected via a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Of the 1,501 recorded participants, 1,185 received the full questionnaire. Bias may be evident in the data because of the significant number of individuals who were not administered the full questionnaire.

Note: Data from Canada were unacceptable. Germany did not authorize reporting of the IPQ data. According to IEA standards, low participation rates are < 60%. For more information, see the TEDS-M technical report (Tatto, 2012).

Limitation annotations for future lower-secondary teacher data

a. *Botswana:* the sample size was small ($n = 53$), but it arose from a census of a small population.
b. *Chile:* the combined participation rate was between 60 and 75%.
c. *Georgia:* the combined participation rate was 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.
d. *Norway:* the combined participation rate was 58%. Program types ALU, ALU plus mathematics, and Master's are reported separately because the populations partly overlap; data from these program types cannot therefore be aggregated.
e. *Poland:* the combined participation rate was between 60 and 75%. The institutions not covered were those providing consecutive programs only.
f. *Russian Federation:* an unknown percentage of surveyed future teachers were already certificated primary teachers.
g. *Switzerland:* the only institutions covered were those where German is the primary language of use and instruction.
h. *United States:* only public institutions were covered. The combined participation rate was between 60 and 75%. An exception was made to accept data from one institution because one additional participant would have brought the response rate to above the 50% threshold. Although the participation rate for the complete sample met the required standard, the data contain records that were completed via a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Of the 607 recorded participants, 502 received the full questionnaire. Bias may be evident in the data because of the significant number of individuals who were not administered the full questionnaire.

Note: Data from Canada were unacceptable. Germany did not authorize reporting of the IPQ data. According to IEA standards, low participation rates are < 60%. For more information, see the TEDS-M technical report (Tatto, 2012).

4.4.1 Age of Future Teachers at the Time of the Assessment

The mean age of the future teachers at the time of the assessment—which was assumed to be their age upon graduation—ranged from about 21 to 29 years, as is shown in Exhibit 4.10. The oldest graduates were found in Germany and Norway (ALU plus mathematics) and in Singapore, where the respective average ages were higher than 27 years. Future primary teachers in Georgia and the Philippines were younger, on average, at the time of graduation.

At the secondary level, the average age of the future teachers at the time of the assessment was greater than that of their counterparts in the primary groups, with mean ages ranging from 21 to almost 32 years. The highest mean ages of future lower-secondary teachers were found in Germany and Norway, while the youngest mean ages were found in the Philippines, Georgia, Oman, the Russian Federation, Malaysia, and Thailand.

Exhibit 4.10: Future teachers' ages at the time of the TEDS-M assessment (estimated mean in years)

Country	Future Primary Teachers				Future Lower-Secondary Teachers			
	n		Est.	*(SE)*	*n*		Est.	*(SE)*
Botswana	86	a	26.0	(0.7)	52	a	24.2	(0.5)
Chile†	636	b	23.6	(0.1)	725	b	23.9	(0.1)
Chinese Taipei	921		23.2	(0.1)	365		24.0	(0.1)
Georgia	502		21.3	(0.1)	74	c	21.3	(0.1)
Germany†	1,020		27.4	(0.2)	763		29.8	(0.4)
Malaysia	568		25.9	(0.1)	383		22.6	(0.1)
Norway (ALU)†	389	c	24.2	(0.3)	354	d	24.3	(0.3)
Norway (ALU+)†	159	c	28.8	(0.5)	150	d	28.3	(0.5)
Norway (PPU & Master's)					65	d	31.9	(1.1)
Oman					267		21.9	(0.0)
Philippines	591		20.9	(0.2)	731		21.0	(0.2)
Poland†	2,110	d	25.2	(0.2)	298	e	23.2	(0.1)
Russian Federation	2,232	e	24.2	(0.5)	2,133	f	22.0	(0.1)
Singapore	379		26.7	(0.3)	392		26.8	(0.2)
Spain	1,093		23.6	(0.4)				
Switzerland	934	f	23.9	(0.1)	141	g	26.3	(0.4)
Thailand†	659		22.3	(0.0)	651		22.4	(0.0)
United States†	1,499	g	25.4	(0.3)	606	h	26.1	(0.5)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The target populations of future primary and lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated earlier on page 117 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

4.4.2 Gender

The majority of future teachers at the primary level in all countries were females, and the same was true for future lower-secondary teachers in most countries. Exhibit 4.11 presents a summary of the relevant data.

In the primary program-groups, the future teachers who were preparing to teach to Grade 4 maximum—that is, those in Group 1—were most likely to be female. Higher proportions of males were found in the groups preparing to teach to Grade 6. Among the future lower-secondary teachers in Program-Groups 5 and 6, more than 50% in Group 5 in Botswana, Chinese Taipei, and Switzerland were male, as were 50% or more in Group 6 in Botswana, Singapore, and Norway. Females still predominated (with over 70%) in Group 5 in Chile, Germany, Poland, Norway, and the United States. The same can be said for Group 6 in Georgia, Malaysia, Poland, the Russian Federation, and Thailand.

4.4.3 Future Teachers' Self-Reported Level of Achievement in Secondary School

To gain a sense of future teachers' academic achievement in secondary school, the TEDS-M research team included an item on the questionnaire that asked, "In secondary school, what was the usual level of marks or grades that you received?" Exhibits A4.13 and A4.14 in Appendix A provide a summary of the future teachers' responses to this item.

Among those preparing to teach in the primary grades, a large proportion reported being "usually near the top of my year level," or "generally above average for my year level." These future teachers included those in Georgia and the Russian Federation in Program-Group 1, Chinese Taipei, Singapore, Switzerland, and the United States in Program-Group 2, Botswana, Chile, and Norway in Program-Group 3, and all of the future teachers in Program-Group 4 (primary mathematics specialists). However, in a number of countries, many future teachers placed themselves one step lower, within the range "generally about average for my year level" and "generally below average for my year level." This was the case in Germany, Poland, and Switzerland in Program-Group 1 and in the Philippines and Spain in Program-Group 2. These findings suggest that programs aimed at training teachers for the higher grades purposefully recruit candidates who gain high levels of achievement while at secondary school.

Most of the future teachers preparing to teach secondary school reported being either "always" or "usually near the top" of their class in secondary school; their reported achievement levels were therefore higher, on average, than the levels that their future primary teacher counterparts reported. Some exceptions were found among students in Program-Group 5 in Chile, Germany, and the Philippines. These students placed themselves within the "generally above average for my year level" and "generally average for my year level" categories. Larger proportions of those in Program-Group 6 in all countries other than Thailand and Germany placed themselves either in the "always" or "usually near the top" categories for their year level.

Very low proportions of future teachers categorized themselves as "generally below average" for their year level. Overall, these findings show that the higher the grade future teachers are expected to teach is, the higher their self-reported level of achievement in secondary school is.

Exhibit 4.11: Gender of future teachers (estimated percent female)

Country	Future Primary Teachers												Future Lower-Secondary Teachers					
	Lower Primary (to Grade 4 Maximum)			*Primary (to Grade 6 Maximum)*			*Primary and Secondary (to Grade 10 Maximum)*			*Primary Mathematics Specialists*			*Lower Secondary (to Grade 10 Maximum)*			*Lower and Upper Secondary (to Grade 11 and above)*		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	[a]						86	59.5	(1.8)				[a] 34	43.6	(3.0)	19	26.3	(5.3)
Chile†	[b]						654	85.4	(1.5)				[b] 746	83.7	(1.6)			
Chinese Taipei				923	71.8	(1.5)										365	38.3	(2.2)
Georgia	502	100.0	(0.0)										[c]			76	84.3	(3.8)
Germany†	934	93.2	(0.9)							95	82.3	(6.2)	405	73.1	(3.1)	362	54.0	(2.3)
Malaysia										569	63.2	(1.4)				386	81.6	(1.6)
Norway (ALU)†	[c]						392	76.2	(1.9)				[d] 354	73.9	(2.4)			
Norway (ALU+)†	[c]						159	67.9	(3.5)				[d] 150	62.7	(4.9)			
Norway (PPU & Master's)													[d]			65	45.4	(4.1)
Oman																268	59.8	(2.2)
Philippines				591	81.1	(2.3)							731	65.4	(3.0)			
Poland†	[d] 1,811	98.0	(0.4)							299	77.9	(2.3)	[e] 158	76.7	(4.3)	140	74.1	(4.3)
Russian Federation	[e] 2,260	93.9	(1.4)										[f]			2,139	70.7	(2.1)
Singapore				263	76.0	(2.4)				117	69.9	(3.6)	141	57.0	(4.4)	251	43.4	(2.4)
Spain				1,093	80.5	(1.4)												
Switzerland	[f] 121	95.5	(2.0)	815	83.4	(1.0)							[g] 141	42.4	(4.9)			
Thailand†										659	74.9	(1.3)				652	75.1	(1.4)
United States†	[g]			1,309	89.8	(1.6)				190	82.5	(8.5)	[h] 169	83.3	(5.7)	437	62.8	(2.8)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The target populations of future primary and lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated earlier on page 117 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

4.4.4 Indicators of Socioeconomic Status of Future Teachers

The questionnaires the future teachers completed included several items that featured indicators of the socioeconomic status of these students and their families. The indicators were number of books in the homes of the students' parents or guardians (few, one bookshelf, one bookcase, two bookcases, and three or more bookcases), the availability of a variety of educational resources in those homes (calculator, computer, study desk, dictionary, encyclopedia, play station, DVD player, and several automobiles), and the highest level of education completed by their male and female parents or guardians. The future teachers' responses are summarized in Exhibits A4.15 through A4.22 in Appendix A.

4.4.4.1 Books in the home

The number of books in a person's home is frequently taken in the IEA studies as an indicator of socioeconomic status. Most of the future teachers preparing to teach primary grades reported having enough books at home "to fill one or two bookcases," with the exception of some future teachers in Botswana and the Philippines. A relatively large proportion of the future teachers in these two countries (30 to 35%) reported having few or no books at home. The only countries where more than 40% of future primary teachers reported having enough books to fill three or more bookcases were Germany, Switzerland, Norway, and the United States. A very similar pattern appeared among future teachers preparing to teach secondary grades. These findings are similar to those reported in Chapter 3: individuals in wealthier countries tend to have more resources—in this case, books—than those in the less wealthy economies.

4.4.4.2 Educational resources at home

Ninety percent or more of the future primary teachers in 12 countries said they owned a calculator. The exceptions were found in Georgia and Botswana, with 85 and 89%, respectively, owning a calculator. Similarly, more than 90% of the future primary teachers in most countries reported owning a study desk and a dictionary (see Exhibit A4.17 in Appendix A). In this case, exceptions were found in Georgia, the Philippines, Botswana, and Thailand, where lower percentages (ranging from 71 to 86%) were recorded. More than 90% of future primary teachers in the majority of participating countries surveyed owned computers. The exceptions came from Georgia (26%), Botswana (38%), the Philippines (38%), Thailand (76%), and the Russian Federation (78%). Across countries, 70% or more of the surveyed preservice students reported owning a DVD player. The only exception to this pattern was evident in Georgia, where fewer than 50% of the preservice students said they had a DVD player. Across the participating countries, greater variation was evident with respect to owning an encyclopedia, a play station, and several cars.

The patterns that emerged for the secondary program-groups differed somewhat from those for the primary program-groups. While almost all future lower-secondary teachers reported owning a calculator, lower proportions said that they owned a computer. Fewer than 50% of the future lower-secondary teachers in Botswana, the Philippines, and Thailand reported owning computers. A higher proportion (80% or more) of future teachers in the two secondary groups said they owned a study desk, a dictionary, and a DVD player. More variability was observed with respect to play station and car ownership.

4.4.5 Level of Education in the Family

Twenty-five percent or more of the future primary teachers in the Philippines, Singapore, Spain, Botswana, Malaysia, and Thailand said that the highest level of their parents' or guardians' education was primary school. Thirty percent or more of the future primary teachers in Chile, Chinese Taipei, Poland, Singapore, Switzerland, and the United States said the highest level of educational attainment for their mothers and fathers was upper secondary. About 40% of respondents in Georgia and the Russian Federation reported practical, technical, or vocational training at the post-secondary level (ISCED Level 5B) as the highest level of maternal education.

Although these patterns were very similar for the future secondary teachers, parents or guardians of future upper-secondary teachers had higher levels of education than those from the other program groups. More than 20% of parents or guardians in Germany, Norway (PPU and Master's), Poland, the Russian Federation, and the United States had reached a level of education beyond ISCED Level 5A. Overall, fathers and male guardians had a lower level of educational attainment than mothers and female guardians.

4.4.6 Language Spoken at Home

Answers to this question indicated two important characteristics of future teachers: how well respondents to the TEDS-M tests and questionnaires spoke the country's official language, and whether these respondents were immigrants. Results are summarized in Exhibit 4.12.

Sizeable proportions of the future primary teachers in most countries said that they always or almost always spoke the language of the test at home. In several countries, however, significant proportions of teachers indicated that they only sometimes or never spoke the language of the test at home. The countries concerned were Botswana (90%), Chinese Taipei (about 30%), Malaysia (about 87%), the Philippines (about 95%), Singapore (about 43%), and Thailand (about 39%). The pattern was similar among future lower-secondary teachers, with Oman (about 28%) being added to the list of countries where a sizable proportion of the respondents said that they sometimes or never spoke the language of the test at home.

4.4.7 Previous Careers and Future Commitment to Teaching

The two future teacher questionnaires also addressed preservice students' previous work experience and their commitment to a teaching career. One item focused on whether these prospective teachers had pursued another career before deciding to become teachers. More particularly, respondents were asked whether or not they had been involved in "another career" prior to commencing their teacher education program. "Career" was defined as paid employment that respondents regarded as likely to be their life's work.

As shown in Exhibit 4.13, about one fourth to one third of the Program-Group 1 future teachers in Germany and Poland reported having been employed in a career-oriented job before they began their teacher education program; lower proportions gave the same response in other countries. A higher proportion of those preparing to teach the more advanced primary grades reported having had another career. Forty percent or more of these future teachers gave the same response in the Philippines, Singapore, and Spain. Lower proportions reported having had another career in Chinese Taipei, Switzerland, and the United States. Among the future teachers in Program-Groups 3 and 4, many said they had worked in other careers. The highest proportion giving this response resided in Singapore (close to 60%) and the lowest proportions giving this response were in Poland, Thailand, and the United States.

Exhibit 4.12: Future teachers' use of the language of the test at home (estimated percent)

Country	Future Primary Teachers									Future Lower-Secondary Teachers								
		Always		Almost Always		Sometimes		Never			Always		Almost Always		Sometimes		Never	
	n	Est.	(SE)	Est.	(SE)	Est.	(SE)	Est.	(SE)	n	Est.	(SE)	Est.	(SE)	Est.	(SE)	Est.	(SE)
Botswana	[a] 81	2.2	(1.6)	7.5	(2.4)	74.2	(5.6)	16.1	(4.6)	[a] 49	0.0	(0.0)	2.4	(2.3)	77.2	(5.8)	20.4	(5.5)
Chile†	[b] 653	97.0	(0.6)	2.4	(0.6)	0.6	(0.2)	0.0	(0.0)	[b] 741	95.4	(0.8)	3.6	(0.6)	0.7	(0.3)	0.4	(0.2)
Chinese Taipei	923	17.1	(1.3)	53.3	(2.0)	28.2	(1.9)	1.4	(0.4)	365	15.5	(1.6)	43.8	(2.1)	37.1	(2.3)	3.6	(0.9)
Georgia	494	86.2	(1.8)	10.5	(1.5)	3.1	(0.7)	0.2	(0.2)	[c] 77	91.9	(3.8)	4.2	(2.4)	1.0	(1.0)	2.8	(2.8)
Germany†	900	93.0	(1.3)	4.8	(1.0)	2.1	(0.8)	0.1	(0.1)	635	90.8	(2.8)	6.0	(2.1)	1.3	(0.5)	1.9	(1.7)
Malaysia	572	6.0	(0.9)	6.8	(1.1)	69.2	(2.1)	17.9	(1.8)	386	4.0	(0.9)	5.6	(1.1)	70.6	(2.0)	19.8	(2.0)
Norway (ALU)†	[c] 391	95.6	(1.2)	3.3	(1.0)	0.5	(0.3)	0.6	(0.5)	[d] 355	97.2	(0.7)	2.3	(0.7)	0.3	(0.3)	0.2	(0.2)
Norway (ALU+)†	[c] 159	94.7	(1.0)	2.3	(1.2)	2.4	(0.9)	0.5	(0.5)	[d] 150	92.8	(2.3)	4.7	(1.9)	1.2	(0.7)	1.3	(0.8)
Norway (PPU & Master's)										[d] 65	85.7	(4.4)	7.8	(3.0)	3.1	(0.3)	3.5	(2.0)
Oman										266	58.6	(3.6)	13.1	(2.4)	20.2	(2.7)	8.2	(1.5)
Philippines	590	0.3	(0.2)	4.7	(1.4)	90.9	(1.6)	4.1	(0.8)	730	1.2	(0.4)	6.2	(1.2)	86.3	(1.5)	6.3	(0.9)
Poland†	[d] 2,111	96.3	(0.5)	2.9	(0.4)	0.8	(0.3)	0.0	(0.0)	[e] 298	97.7	(1.0)	1.8	(0.9)	0.5	(0.4)	0.0	(0.0)
Russian Federation	[e] 2,261	85.4	(3.7)	7.6	(1.7)	6.0	(1.8)	1.0	(0.3)	[f] 2,140	85.5	(3.7)	6.9	(1.1)	6.2	(2.4)	1.4	(0.7)
Singapore	380	30.7	(2.5)	26.5	(2.2)	36.5	(2.2)	6.3	(1.3)	391	13.6	(1.6)	19.5	(1.7)	49.7	(2.2)	17.2	(2.2)
Spain	1,092	79.7	(3.4)	6.4	(1.3)	4.9	(0.6)	8.9	(2.9)									
Switzerland	[f] 932	84.5	(0.9)	9.4	(0.9)	2.6	(0.5)	3.5	(0.5)	[g] 141	86.1	(2.9)	6.5	(2.0)	3.1	(1.6)	4.3	(1.5)
Thailand†	660	50.8	(1.6)	10.4	(1.0)	33.1	(1.5)	5.7	(1.0)	652	51.6	(1.6)	10.7	(1.2)	32.2	(1.4)	5.5	(0.9)
United States†	[g] 1,186	94.8	(1.1)	3.4	(0.6)	1.4	(0.5)	0.4	(0.4)	[h] 502	93.5	(1.7)	2.9	(0.9)	3.3	(1.3)	0.4	(0.3)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The target populations of future primary and lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated earlier on page 117 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit 4.13: Future teachers' responses on whether they had another career before entering teaching (estimated percent responding "yes")

Country	Future Primary Teachers												Future Lower-Secondary Teachers					
	Lower Primary (to Grade 4 Maximum)			*Primary (to Grade 6 Maximum)*			*Primary and Secondary Generalists (to Grade 10 Maximum)*			*Primary Mathematics Specialists*			*Lower Secondary (to Grade 10 Maximum)*			*Lower and Upper Secondary (to Grade 11 and above)*		
	n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Botswana	[a]						59	27.4	(6.6)				[a] 23	13.0	(7.8)	6	33.3	(23.0)
Chile†	[b]						649	31.9	(1.9)				[b] 730	34.3	(1.7)			
Chinese Taipei				922	5.6	(0.7)										365	4.9	(1.2)
Georgia	427	10.8	(2.1)													68	7.6	(3.0)
Germany†	934	26.5	(2.1)							95	24.7	(6.1)	405	33.5	(3.1)	362	30.8	(2.5)
Malaysia										567	41.7	(2.1)				386	26.4	(1.9)
Norway (ALU)†	[c]						390	26.2	(2.2)				[c] 354	21.9	(2.3)			
Norway (ALU+)†	[c]						159	39.2	(3.8)				[c] 149	38.1	(3.8)			
Norway (PPU & Master's)													[d]			65	44.4	(4.3)
Oman																249	4.0	(1.2)
Philippines				552	48.5	(2.9)							675	51.1	(2.7)			
Poland†	[d] 1,805	31.6	(1.2)							299	9.9	(1.5)	[d] 158	14.6	(3.5)	138	10.7	(3.0)
Russian Federation	[e] 2,256	14.9	(1.7)										[e]			2,129	7.7	(0.9)
Singapore				263	43.8	(3.3)				117	56.9	(3.8)	141	36.7	(3.7)	250	35.6	(3.2)
Spain				1,090	44.7	(4.0)												
Switzerland	[f] 119	17.3	(3.4)	814	25.5	(1.7)							[f] 140	22.2	(3.8)			
Thailand†										658	4.1	(0.7)				650	6.1	(0.8)
United States†	[g]			1,032	18.7	(1.8)				149	15.6	(3.9)	[g] 131	16.9	(2.5)	369	23.1	(3.3)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The target populations of future primary and lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this table, keep in mind the limitations annotated earlier on page 117 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

The pattern was similar in the secondary program-groups. Twenty percent or more of future teachers in 7 of the 10 countries in Program-Group 5 reported having had other careers; the highest proportion was in the Philippines (about 51%). The lowest prior career rates were found in Botswana, Poland, and the United States (with a range of about 13 to 17%).

Chinese Taipei, Georgia, Oman, Poland, the Russian Federation, and Thailand had the lowest proportions (between 4 and 10.7%) of Group 6 future teachers who had worked in another career before entering teaching. Higher proportions of Group 6 future teachers with previous careers were found in Norway (PPU and Master's) (close to 44%), Singapore (35.6%), Botswana (33.3%), and Germany (30.8%).

4.4.8 Reasons for Becoming a Teacher

Future teachers were shown a list of nine reasons people might have for wanting to become teachers, and were asked to identify those that had been a significant or major reason for them. The reasons encompassed the nature of the teaching task, personal wellbeing, and a desire to benefit others. Results for future primary teachers and for future lower-secondary teachers are shown in Exhibits A4.23 and A4.24 (Appendix A) respectively.

Because teaching largely involves interacting with students, it is no surprise that high proportions of the future teachers in most program-groups selected "I like working with young people." Groups 5 and 6 future teachers were those least likely to select this reason. Interestingly, this reason was much less likely to be chosen by future teachers in Chinese Taipei, Georgia, and Thailand, the only three countries for which the most commonly chosen reason in one or more program-groups was "the long-term security associated with being a teacher." Because high percentages of future teachers in all other countries chose liking to work with young people, other highly favored choices will be of interest to those involved in teacher recruitment.

The numbers of future teachers selecting "I love mathematics" produced a revealing trend in attitudes across program-groups. This reason was usually neither the first nor the second most frequent choice of future teachers in any country in either Group 1 or Group 2, but it was the most frequent choice in one country, Botswana, and for one group (Group 3). For Group 4 future teachers in three countries (Malaysia, Poland, and Thailand), this reason was the first or second most frequent choice. The only future teachers in Group 5 to choose this reason more often than their counterparts in any other group were those in Botswana. However, it was the first or second most favored choice for Group 6 future teachers in nine countries.

High percentages of future teachers from Germany, Chile, Norway, Switzerland, and the United States said they entered teaching because they believed they had "a talent for teaching." Seeing teaching as a "challenging job" was identified as an important reason by future teachers in Chile, Germany, Norway, the Philippines, and Switzerland. The statement was endorsed by more than 85% of the future teachers in these countries.

Wanting to "have an influence on the next generation" motivated large proportions of future teachers in Group 1 in the Russian Federation, Group 2 in Singapore, Spain, and the United States, Group 5 in the Philippines, Singapore, and the United States, and Group 6 in Thailand.

It appears that neither having been a "good student in school" nor "availability of teaching positions" greatly influenced future teachers to become teachers. Overall, the least frequently chosen reason was "I am attracted by teacher salaries."

4.5 Conclusion

Although the number of participating countries was not large, and the cultural and socioeconomic differences among them were, it is still possible to discern a number of trends and patterns that are likely to interest policymakers, researchers, teacher educators, and others. We present these under the three headings corresponding to the major subsections of the chapter: teacher education institutions, teacher educators, and future teachers.

National research coordinators, who were responsible for collecting the TEDS-M data from representative samples of their teacher education institutions, their teacher educator population, and their future teachers, had to deal with a number of challenges unique to conducting a study of this kind at the post-secondary level. Samples for some countries were small or response rates were lower than expected, and this means that caution must frequently be exercised in interpreting the data from those countries. All such cautions are indicated in the annotated panels associated with the exhibits throughout this chapter.

4.5.1 Teacher Education Institutions and Programs

Mathematics teacher education in every nation is structured and organized in a variety of ways that have been shaped by history and tradition in that country, as well as by current perceptions of the things that teachers need to know and be able to do in order to teach successfully. The response to these kinds of constraints is diverse, as can be seen from the high degree of variation in the characteristics of teacher education programs across countries.

There is considerable variation among countries in the length of programs considered necessary to prepare teachers for the classroom. There is also great variation across countries, and across programs within countries, in the amount of class time the teacher education programs allocate to mathematics and mathematics pedagogy. Institutions in low-income countries tend to have lower minimum entry qualifications, regardless of program level. Where minimum qualifications are lower, there is usually more emphasis on prior achievement in mathematics.

Almost all teacher education programs include extended teaching practice, but fewer include field experience that enables future teachers to become familiar with school organizational and managerial issues. In order to graduate, students in most of the TEDS-M countries must demonstrate readiness for teaching in addition to teaching competence by gaining passing grades in all subjects, written and/or oral examinations, and/or theses. Programs for future secondary teachers are more likely to require a thesis for graduation than programs for future primary teachers.

4.5.2 Teacher Educators

Teacher educators were primarily females who had, for the most part, specialized roles within their programs. However, some of these programs had teacher educators who were playing multiple roles, who were not highly qualified, and who did not consider mathematics to be their main specialty. Teacher educators teaching mathematics in countries with high- or medium-income levels usually had high-level qualifications. Most of the teacher educators teaching mathematics and mathematics pedagogy courses considered themselves to be mathematics specialists. Large proportions of teacher educators were certified teachers.

4.5.3 Future Teachers

The majority of future primary teachers at the primary school level were females, by a wide margin. There were greater proportions of men among the lower-secondary samples, but females were still predominant in at least half of the participating countries.

These individuals often decide to pursue a career in teaching because they like working with young people, and because they think they might be good at teaching even though they see teaching as a challenging job and one that will not give them good salaries. Most are of middle-class background and, with the exception of those from less-developed countries, have access to a number of resources at home, such as calculators, computers, and dictionaries. For the most part, these individuals have been successful in their basic schooling. However, with the exception of those in a few countries who were intending to teach high school mathematics, they did not see themselves as having been high achievers in secondary school, a perception that may have had implications for the kinds of opportunities they will be able to provide for their own students.

References

Tatto, M. T. (2012). *Teacher Education and Development Study in Mathematics (TEDS-M): Technical report*. Amsterdam, the Netherlands: International Association for Educational Achievement (IEA).

Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). *Teacher Education and Development Study in Mathematics (TEDS-M): Conceptual framework*. Amsterdam, the Netherlands: International Association for Educational Achievement (IEA). Available online at http://teds.educ.msu.edu/framework.asp

CHAPTER 5:

THE MATHEMATICS CONTENT KNOWLEDGE AND MATHEMATICS PEDAGOGICAL CONTENT KNOWLEDGE OF FUTURE PRIMARY AND LOWER-SECONDARY TEACHERS

5.1 Chapter Overview

TEDS-M was designed to answer questions about the knowledge of future teachers across participating countries. In this chapter, we address the following research questions:

1. What are the level and depth of the knowledge for teaching mathematics attained by prospective primary and lower-secondary teachers?
2. How does this knowledge vary across countries?

Studying the knowledge that future teachers have at hand is important for two main reasons. First, teachers' knowledge influences the mathematics achievement of their students (Baumert et al., 2010; Hill, Rowan, & Ball, 2005). Second, the knowledge that future teachers have acquired by the end of their final year of study may be a key indicator of the success of their teacher education program.

This chapter consists of four sections. The first describes the framework and procedures used to develop the TEDS-M items that measured future teachers' knowledge for teaching mathematics. The second describes the design of the instruments used. The third section presents results related to the research questions, and the last section contains concluding comments.

5.2. Framework for Measuring Knowledge for Teaching Mathematics

Knowledge for teaching requires both *content knowledge* and *pedagogical content knowledge* (Committee on the Study of Teacher Preparation Programs in the United States, 2010; Shulman, 1987). Over the past few decades, scholars from around the world have described how these two constructs can be interpreted with respect to teaching mathematics (An, Kulm, & Wu, 2004; Conference Board of the Mathematical Sciences, 2001; Even & Ball, 2009; Hill, Rowan, & Ball, 2005; Pepin, 1999; Schmidt et al., 2007). The TEDS-M research team drew on this research to design the items and instruments used to measure the mathematics content knowledge (MCK) and the mathematics pedagogical content knowledge (MPCK) of preservice teachers intending to teach in primary or lower-secondary schools.

5.2.1 Framework for Mathematics Content Knowledge

Items spanning four content subdomains were used to assess MCK at both the primary and lower-secondary levels. The four subdomains were number and operations, algebra and functions, geometry and measurement, and data and chance. These were derived from the subdomains used in the assessment frameworks for IEA's Trends in Mathematics and Science Study (TIMSS) (see Exhibit 5.1).

Each MCK item was further classified into one of three cognitive subdomains: knowing, applying, and reasoning (see Exhibit 5.2). This framework was based on descriptions of the cognitive domains used in TIMSS (Garden et al., 2006; Mullis, Martin, Ruddock, O'Sullivan, Arora, & Erberber, 2007).

Adopting these familiar frameworks provided a focus for item development, ensured good coverage of MCK, and also enabled items to be systematically categorized for scale development and reporting.

Exhibit 5.1: Mathematics content knowledge framework, by content subdomain

Subdomain	Sample Topics
Number and Operations	Whole numbers Fractions and decimals Number sentences Patterns and relationships Integers Ratios, proportions, and percentages Irrational numbers Number theory
Geometry and Measurement	Geometric shapes Geometric measurement Location and movement
Algebra and Functions	Patterns Algebraic expressions Equations/formulas and functions Calculus and analysis* Linear algebra and abstract algebra*
Data and Chance	Data organization and representation Data reading and interpretation Chance

Note: * Lower-secondary level only.

Source: *TIMSS 2007 Content Domain Assessment Framewor*k (Mullis et al., 2007); *TIMSS 2008 Advanced Assessment Frameworks* (Garden et al., 2006).

Exhibit 5.2: Mathematics content knowledge framework, by cognitive domain

Subdomain	Sample Behaviors
Knowing	Recall Recognize Compute Retrieve Measure Classify/order
Applying	Select Represent Model Implement Solve routine problems
Reasoning	Analyze Generalize Synthesize/integrate Justify Solve non-routine problems

Source: *TIMSS 2007 Cognitive Domain Assessment Framework* (Mullis et al., 2007).

5.2.2 Framework for Mathematics Pedagogical Content Knowledge

The framework for MPCK in TEDS-M evolved from a review of the literature and was informed by the framework used in the Mathematics Teaching in the 21st Century Project (MT21). The project encompassed a study in six countries of programs preparing future teachers intending to teach mathematics in lower-secondary grades, and it was designed as a precursor to TEDS-M (Schmidt, Blömeke, & Tatto, 2011). The final version of the MPCK framework was arrived at after international experts in the field had completed a critical review. As indicated in Exhibit 5.3, items addressing MPCK spanned three subdomains: curricular knowledge, planning for teaching and learning, and enacting teaching and learning. Each MPCK item was further classified by content and curricular level.

Exhibit 5.3: Mathematics pedagogical content knowledge (MPCK) framework

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

Many original items were written for TEDS-M; this was especially true of items relating to the primary level. Some items were obtained and used with permission from other studies, such as the Learning Mathematics for Teaching Projects (Hill & Ball, 2004) and the Mathematics Teaching for the 21st Century Project (Schmidt et al., 2011). Mathematics educators in the participating TEDS-M countries also submitted some items. International panels of mathematicians and mathematics educators reviewed each item for clarity and the extent to which it was consistent with its classification on the MCK or MPCK framework.

All items had one of three formats: multiple-choice (MC), complex multiple-choice (CMC), and constructed response (CR). Scoring guides were developed for all CR items. All items, scoring guides, and booklet designs (see Section 5.2) were field tested internationally. The final test booklets contained only items with measurement properties deemed appropriate for all participating countries.

Sample items illustrating each item format from both primary and secondary surveys appear later in this chapter, and a set of released items is available on the TEDS-M website (http://teds.educ.msu.edu/). For a more detailed description of the MCK and MPCK frameworks and the item development and adaptation procedures, see Chapter 3 of the conceptual framework (Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008), which is also available on the TEDS-M website, in Senk, Peck, Bankov, & Tatto (2008), and the TEDS-M technical report (Tatto, 2012).

5.3 Instrument Design

The field trial indicated that respondents should have no more than 90 minutes to complete the surveys of future primary and lower-secondary teachers. Exhibit 5.4 shows the overall booklet structure for the surveys and the time that respondents would ideally spend on each part of them. This structure was adopted in the main study.

Exhibit 5.4: Overall structure of booklets for the future teacher surveys and allocated times for administration

Part	Time (minutes)
A: General Background	5
B: Opportunity to Learn	15
C: Mathematics for Teaching	60
D: Beliefs about Mathematics and Teaching	10

The instruments focusing on mathematics for teaching were administered as Part C of the future teacher surveys. Approximately two-thirds of the items on each of the primary and lower-secondary surveys addressed MCK, and one-third addressed MPCK. About 30% of the items in Part C of each survey addressed each of the number, geometry, and algebra subdomains, and about 10% addressed data and chance. To ensure adequate coverage of both MCK and MPCK within the limited testing time available, rotated block designs were used with each of the primary and lower-secondary surveys. This process ensured domain coverage given that each future teacher completed only a portion of the total number of items administered.

5.3.1 Survey for Future Primary Teachers

The TEDS-M field trial indicated that, on average, primary respondents were able to answer approximately 24 questions in 60 minutes. Therefore, the primary MCK and MPCK items were separated into five blocks (called B1 to B5), with each block containing an average of 12 questions, many with several parts (items).

Five primary booklets were constructed, each containing two blocks of questions. Thus, for example, a primary future teacher receiving Booklet 1 would see the questions in Blocks 1 and 2. The rotation also ensured that each item appeared at two different positions, thereby reducing booklet effect. Exhibit 5.5 shows the design of the primary booklets.

Exhibit 5.5: TEDS-M rotated block design for the primary survey of knowledge of mathematics for teaching

Booklet	Blocks Administered	
1	B_1	B_2
2	B_2	B_3
3	B_3	B_4
4	B_4	B_5
5	B_5	B_1

5.3.2 Survey for Future Lower-Secondary Teachers

At the lower-secondary level, the small size of target populations within some institutions, some programs, and some countries imposed still further restrictions, a situation that permitted a maximum of three booklets. The field trial showed that future lower-secondary teachers were able to answer about 30 questions in 60 minutes. Lower-secondary blocks containing an average of 15 questions were therefore constructed. Each future teacher of secondary mathematics responded to two blocks of questions, with each question worth one to four score points. Exhibit 5.6 shows the three-booklet design for the TEDS-M main study at the lower-secondary level.

Exhibit 5.6: TEDS-M rotated block design for the lower-secondary survey of knowledge of mathematics for teaching

Booklet	Blocks Administered	
1	B_1	B_2
2	B_2	B_3
3	B_3	B_1

5.4 Future Teachers' Knowledge of Mathematics for Teaching

As described in Appendix B to this report, future teachers' knowledge of mathematics content and mathematics pedagogical content is reported in scaled scores generated through use of item response theory (IRT). The primary knowledge scales were built from 74 MCK items and 32 MPCK items, and the lower-secondary scales were built from 76 MCK items and 27 MPCK items. The international mean for each of the primary and lower-secondary MCK and MPCK scales was 500; the standard deviation was 100.

When interpreting the results presented and discussed in the exhibits in this section, bear in mind the following annotations pertaining to the data from several countries. The annotations are listed in two panels—one for the primary teacher data, and one for the lower-secondary teacher data.

Limitation annotations for the future primary teacher MCK and MPCK data

a. *Poland:* reduced coverage—institutions with consecutive programs only were not covered; the combined participation rate was between 60 and 75%.

b. *Russian Federation:* reduced coverage—secondary pedagogical institutions were excluded.

c. *Switzerland:* reduced coverage—the only institutions covered were those where German is the primary language of use and instruction.

d. *United States:* reduced coverage—public institutions only; the combined participation rate was 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. Although the participation rate for the complete sample met the required standard, the data contain records that were completed via a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Of the 1,501 recorded participants, 1,185 received the full questionnaire. Bias may be evident in the data because of the significant number of individuals who were not administered the full questionnaire.

e. *Botswana:* the sample size was small (n = 86), but arose from a census of a small population.

f. *Chile:* the combined participation rate was between 60 and 75%.

g. *Norway:* the combined participation rate was between 60 and 75%. An exception was made to accept data from one institution because one additional participant would have brought the response rate to above the 50% threshold. Program-types ALU and ALU plus mathematics are reported separately because the two populations partly overlapped; data from these program-types cannot therefore be aggregated.

Limitation annotations for the future lower-secondary teacher MCK and MPCK data

a. *Botswana:* the sample size was small (n = 53), but arose from a census of a small population.
b. *Chile:* the combined participation rate was between 60 and 75%.
c. *Poland:* reduced coverage. The institutions not covered were those with only consecutive programs. The combined participation rate was between 60 and 75%.
d. *Switzerland:* reduced coverage—the only institutions covered were those where German is the primary language of use and instruction.
e. *Norway:* The combined participation rate was 58%. An exception was made to accept data from one institution because one additional participant would have brought the response rate to above the 50% threshold. Of the program-types preparing preservice teachers to teach up to Grade 10 maximum, program-types ALU and ALU plus mathematics are reported separately because the populations partly overlapped; data from these program-types cannot therefore be aggregated.
f. *United States:* reduced coverage—public institutions only. The combined participation rate was between 60 and 75%. An exception was made to accept data from one institution because one additional participant would have brought the response rate to above the 50% threshold. Although the participation rate for the complete sample met the required standards, the data contain records that were completed via a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Of the 607 recorded participants, 502 received the full questionnaire. Bias may be evident in the data because of the significant number of individuals who were not administered the full questionnaire.
g. *Georgia:* The combined participation rate was between 60 and 75%. An exception was made to accept data from two institutions because, in each case, one additional participant brought the response rate to above the 50% threshold.
h. *Russian Federation:* an unknown number of those surveyed had previously qualified to become primary teachers.

To help readers interpret the scores on these scales, the TEDS-M researchers identified key points on the scales, called anchor points. The anchor points do not represent a priori judgments about whether a given scale score is good or bad. Rather, they are descriptions of the performance of those future teachers who had scores at specific points on the scale. Two anchor points were identified for each of the MCK primary and lower-secondary scales, and one anchor point for each of the two MPCK scales. On the MCK scales, Anchor Point 1 represents a lower level of knowledge and Anchor Point 2, a higher level.

Items at the anchor points were determined by the probability that a person with a score at that point would get the relevant item right. Future teachers with scores at the anchor points were able to provide correct answers to items classified at that point or below with a probability of 0.70 or greater. Hence, sets of such items were used to develop descriptions of what future teachers at (or above) the anchor points were likely to achieve. Items that future teachers were likely to answer correctly with a probability of less than 0.50 were items that the teachers were unlikely to answer correctly. A panel of mathematicians and mathematics educators analyzed the items classified at these anchor points and formulated descriptions of the knowledge that future teachers at each point held.

5.4.1 Future Primary Teachers' Mathematics Knowledge

This section describes the mathematics knowledge of future primary teachers in the study. It starts with MCK and concludes with MPCK. To help readers understand the levels of knowledge reached by the future teachers across the program-groups, the anchor points are described and then illustrated through reference to a small number of selected released items. Finally, summary tables and charts are provided and commented on in order to facilitate international comparisons.

5.4.1.1 Anchor points for the primary MCK scale

Two anchor points were defined for the primary-level MCK scale. Anchor Point 1, representing a lower level of MCK, corresponds to a scale score of 431. Anchor Point 2, representing a higher level of knowledge, corresponds to a scale score of 516.

- *Primary MCK Anchor Point 1:* future primary teachers scoring at Anchor Point 1 on the primary MCK scale were likely to correctly answer items involving basic computations with whole numbers, identification of properties of operations with whole numbers, and reasoning about odd or even numbers. They were generally able to solve straightforward problems using simple fractions. Future teachers at this anchor point were also likely to achieve success at visualizing and interpreting standard two-dimensional and three-dimensional geometric figures, and solving routine problems about perimeter. They could generally understand straightforward uses of variables and equivalence of expressions, and solve problems involving simple equations.

  Future primary teachers at Anchor Point 1 also tended to over-generalize and have difficulty solving abstract problems and problems requiring multiple steps. They had limited knowledge of proportionality, multiplicative reasoning, and least common multiples, and had difficulty solving problems that involved coordinates and problems about relations between geometric figures. Future primary teachers at Anchor Point 1 were also likely to have difficulty reasoning about multiple statements and relationships among several mathematical concepts (such as understanding that there is an infinite number of rational numbers between two given numbers), finding the area of a triangle drawn on a grid, and identifying an algebraic representation of three consecutive even numbers.
- *Primary MCK Anchor Point 2:* in addition to being able to solve the mathematics tasks that future teachers at Anchor Point 1 could do, future teachers at Anchor Point 2 also tended to be successful at using fractions to solve story problems and at recognizing examples of rational and irrational numbers. They were likely to know how to find the least common multiple of two numbers in a familiar context and to recognize that some arguments about whole numbers are logically weak. They were generally able to determine areas and perimeters of simple figures and had some notion of class inclusion among polygons. Future teachers at Anchor Point 2 also had some familiarity with linear expressions and functions.

> Although future primary teachers at Anchor Point 2 could solve some problems involving proportional reasoning, they often had trouble reasoning about factors, multiples, and percentages. They found applications of quadratic or exponential functions challenging, and they had limited success applying algebra to geometric situations, such as writing an expression for the reflection image of the point with coordinates (a, b) over the x-axis, identifying a set of geometric statements that uniquely define a square, and describing properties of a linear function.

Overall, future teachers at Anchor Point 2 tended to do well on items classified as testing the cognitive domain of knowing, and on standard problems related to numbers, geometry, and algebra and classified as applying. However, they were likely to have more difficulty answering problems requiring more complex reasoning in applied or non-routine situations. For example, the items in Exhibit 5.7 assess whether respondents know that the commutative and associative properties hold for addition of whole numbers, but not for subtraction. Parts A, B, and C illustrate items on which future teachers with scores at Anchor Point 1 or above had high probabilities of success. The item in Part D behaved differently. Although 64% of the international sample answered this item correctly, future teachers with scores at Anchor Point 1 had particular difficulty answering this item correctly: they had a less than 50% chance of responding correctly. However, future primary teachers with scores at or above Anchor Point 2 had higher probabilities of selecting the correct answer.

*Exhibit 5.7: Complex multiple-choice MCK Items MFC202A–D**

Indicate whether each of the following statements is true for the set of all whole numbers *a*, *b* and *c* greater than zero.

Check *one* box in *each* row.

	True	Not True
A. $a - b = b - a$	☐	☐
B. $a \div b = b \div a$	☐	☐
C. $(a + b) + c = a + (b + c)$	☐	☐
D. $(a - b) - c = a - (b - c)$	☐	☐

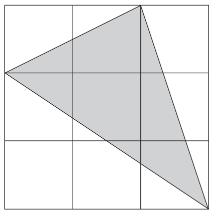
Note: * International average percent correct: MFC202 A (81%), B (86%), C (92%), D (64%).

Exhibit 5.8 shows a geometry item that asked respondents to find the area of a triangle in which neither the magnitude of the base nor the height is indicated. Future primary teachers with scores at or above Anchor Point 2 on the MCK scale were likely to respond correctly to this item. Future primary teachers scoring at Anchor Point 1 were not.

The item depicted in Exhibit 5.9 asks a non-routine algebra question about two expressions in which the underlying mathematics involves the solution of an inequality. Approximately 35% of the international sample of future primary teachers earned some credit on this item. Even future teachers with scores at Anchor Point 2 had less than a 50% chance of responding correctly, either partially or completely, to this item.

*Exhibit 5.8: Multiple-choice MCK Item MFC408**

The area of each small square is 1 cm²



What is the area of the shaded triangle in cm²?

Check *one* box.

A. 3.5 cm² ☐

B. 4 cm² ☐

C. 4.5 cm² ☐

D. 5 cm² ☐

Note: * International average percent correct: 60%.

*Exhibit 5.9: Constructed-response MCK Item MFC509**

Students who had been studying algebra were asked the following question:

For any number n, which is larger, $2n$ or $n + 2$?

Give the answer and show your reasoning or working.

Note: * International average percent correct: full credit (12%), partial credit (21%).

5.4.1.2 MCK results by primary program-group

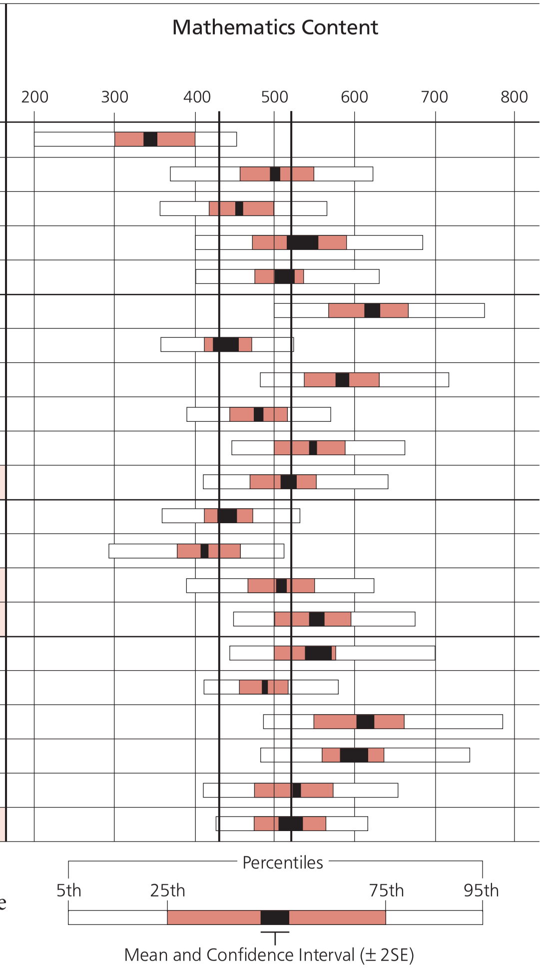
Exhibit 5.10 shows descriptive statistics and box plots of the achievement of future primary teachers in each of the program-groups. MCK Anchor Point 1 (431) and Anchor Point 2 (516) are marked by vertical lines on the display.

Useful comparisons can be made within each country and within each program. Because programs have different goals and structures, it is perhaps less useful for the purposes of this chapter to make comparisons between programs. A characteristic common to all countries in all four primary program-groups, however, is the wide range of achievement within each country. Even the highest achieving countries had some future teachers achieving relatively low scores, and every low-achieving country had some future primary teachers with scores above Anchor Point 1 (431).

A second finding is that, within each program-group, the difference between the highest mean MCK scale score and the lowest mean MCK scale score is at least 100 points, that is, more than one standard deviation. So, on average in some countries, future teachers at the primary level graduate with considerably more content knowledge than others, even when grade level and degree of specialization are similar. Nevertheless, in each program-group, distributions of MCK scale scores overlapped considerably. Thus, even in the lower-scoring countries, there were some future teachers who outperformed some of the future teachers in the higher-scoring countries.

Exhibit 5.10: Future primary teachers' mathematics content knowledge

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Percent at or above Anchor Point 1 (*SE*)	Percent at or above Anchor Point 2 (*SE*)	Scaled Score: Mean (*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	506	0.0	11.9 (1.4)	0.9 (0.5)	345 (4)
	Germany	935	907	2.4	86.4 (1.3)	43.9 (2.1)	501 (3)
	Poland [a]	1,812	1,799	0.9	67.9 (1.3)	16.8 (1.2)	456 (2)
	Russian Federation [b]	2,266	2,260	0.2	89.7 (2.3)	57.3 (4.6)	536 (10)
	Switzerland [c]	121	121	0.0	90.5 (2.7)	44.2 (5.4)	512 (6)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	99.4 (0.3)	93.2 (1.4)	623 (4)
	Philippines	592	592	0.0	60.7 (5.1)	6.3 (0.9)	440 (8)
	Singapore	263	262	0.4	100.0	82.5 (2.3)	586 (4)
	Spain	1,093	1,093	0.0	83.4 (1.6)	26.2 (1.6)	481 (3)
	Switzerland	815	815	0.0	97.2 (0.6)	70.6 (1.4)	548 (2)
	United States † [d]	1,310	951	28.6	92.9 (1.2)	50.0 (3.2)	518 (5)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana [e]	86	86	0.0	60.6 (5.3)	7.1 (2.8)	441 (6)
	Chile [f]	657	654	0.4	39.5 (1.8)	4.0 (0.7)	413 (2)
	Norway (ALU) [g]	392	392	0.0	88.5 (1.5)	46.9 (2.8)	509 (4)
	Norway (ALU+) [g]	159	159	0.0	96.5 (1.4)	68.7 (3.8)	553 (6)
Group 4. Primary Mathematics Specialists	Germany	97	97	0.0	96.0 (2.1)	71.7 (7.0)	555 (8)
	Malaysia	576	574	0.4	88.7 (1.1)	28.1 (1.3)	488 (2)
	Poland [a]	300	300	0.0	97.9 (1.0)	91.0 (1.6)	614 (5)
	Singapore	117	117	0.0	98.3 (1.2)	87.3 (2.8)	600 (8)
	Thailand	660	660	0.0	91.7 (0.9)	56.2 (1.4)	528 (2)
	United States † [d]	191	132	33.2	94.9 (1.7)	48.1 (6.5)	520 (7)



Notes:

1. This table and chart must be read with awareness of the limitations annotated on page 134 of this chapter and denoted in the above by footnote letters.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. The solid vertical lines on the chart show the two anchor points (431 and 516).

Of the future teachers in the five countries with programs that prepare teachers for lower-primary grades (i.e., Program-Group 1), future teachers in the Russian Federation earned the highest mean score. The Russian Federation was the only country in that program-group in which more than half the sample achieved scores at or above Anchor Point 2.

Of the future teachers in the six countries that prepare primary generalists to teach through to Grade 6 (Program-Group 2), future teachers in Chinese Taipei earned the highest mean. Almost all future teachers in that country scored at or above Anchor Point 2. In fact, the mean MCK score of future primary teachers in Chinese Taipei was higher than the scores of future teachers in any other program. Performance was also strong among the Group 2 future teachers in Singapore and Switzerland, where most future teachers scored above Anchor Point 2.

In the programs preparing future teachers for teaching both primary and lower-secondary grades (i.e., the Group 3 programs), respondents in Botswana and in Chile generally found the MCK items difficult. Although the majority of future teachers in Botswana achieved above Anchor Point 1, few achieved above Anchor Point 2. Performance in the two Norwegian programs was higher, with future teachers in the smaller ALU plus program achieving somewhat higher MCK scores than those in the ALU program.

Future teachers in programs for primary mathematics specialists in Group 4 generally performed well with respect to the international sample, with all but one country achieving a mean score greater than 500. Future teachers from Poland and Singapore achieved the highest mean MCK scores in this program-group, and almost all future teachers in both samples scored at or above Anchor Point 2.

5.4.1.3 Primary anchor point for MPCK

Because of the relatively small number of items measuring mathematics pedagogical content knowledge, only one anchor point was defined at the primary level. It represents a score of 544 on the MPCK scale.

Future primary teachers who scored at or above this anchor point were generally able to recognize whether or not a teaching strategy was correct for a particular concrete example, and to evaluate students' work when the content was conventional or typical of the primary grades. They were also likely to identify the arithmetic elements of single-step story problems that influence the difficulty of these problems.

Although future primary teachers at the primary MPCK anchor point were generally able to interpret some students' work, their responses were often unclear or imprecise. In addition, future teachers at this anchor point were unlikely to use concrete representations to support students' learning or to recognize how a student's thinking related to a particular algebraic representation. They were furthermore unlikely to understand some measurement or probability concepts needed to reword or design a task. These future teachers also rarely knew why a particular teaching strategy made sense, if it would always work, or whether a strategy could be generalized to a larger class of problems. They were unlikely to be aware of common misconceptions or to conceive useful representations of numerical concepts.

Exhibit 5.11 shows a primary-level, constructed-response item (MFC505) tapping pedagogical content knowledge about curriculum and planning. This item required future teachers to consider four story problems, each of which can be solved using a single arithmetic operation with whole numbers. The future primary teachers with scores at or above the MPCK anchor point had at least a 70% chance of correctly responding to this item. Virtually all the international sample recognized one or both of the more difficult problems, namely Problem 1, which requires multiplication or repeated addition, and Problem 3, a "separate/start unknown" problem (see Carpenter, Fennema, Franke, Levi, & Empson, 1999).

*Exhibit 5.11: Constructed-response MPCK Item MFC505**

A <Grade 1> teacher asks her students to solve the following four story problems, in any way they like, including using materials if they wish.

Problem 1: [Jose] has 3 packets of stickers. There are 6 stickers in each pack. How many stickers does [Jose] have altogether?

Problem 2: [Jorgen] had 5 fish in his tank. He was given 7 more for his birthday. How many fish did he have then?

Problem 3: [John] had some toy cars. He lost 7 toy cars. Now he has 4 cars left. How many toy cars did [John] have before he lost any?

Problem 4: [Marcy] had 13 balloons. 5 balloons popped. How many balloons did she have left?

The teacher notices that two of the problems are more difficult for her children than the other two.

Identify the TWO problems which are likely to be more **DIFFICULT** to solve for <Grade 1> children.

Problem ________________ and Problem ________________

Note: * International average percent correct: full credit (77%), partial credit (20%).

However, future teachers at or below the MPCK anchor point were unlikely to achieve success on items focused on enacting mathematics teaching, such as Item MFC208 shown in Exhibit 5.12. They had less than a 50% chance of identifying a common misconception about multiplication, namely "that multiplication makes things bigger" or, more formally, that the product results in a larger number than either factor. Nor were future teachers at or below the MPCK anchor point likely to be able to draw a representation that would help children dispel this misconception.

Exhibit 5.12: Constructed-response Items MFC208A–B

[Jeremy] notices that when he enters 0.2 × 6 into a calculator his answer is smaller than 6, and when he enters 6 ÷ 0.2 he gets a number greater than 6. He is puzzled by this, and asks his teacher for a new calculator!

(a) What is [Jeremy's] most likely misconception?

(b) Draw a visual representation that the teacher could use to model 0.2 × 6 to help [Jeremy] understand **WHY** the answer is what it is?

Note: *International average percent correct: 208A full credit (20%), partial credit (12%), 208B full credit (16%), partial credit (16%).

5.4.1.4 MPCK results by primary program-group

Exhibit 5.13 shows descriptive statistics and box plots of the distributions of MPCK scale scores for each country in each program-group; the MPCK anchor point (544) is marked with a vertical line. In programs preparing lower-primary generalists—Program-Group 1—most future teachers scored below the MPCK anchor point but those teachers in two of the five programs achieved means above the international average (500). Among the future generalist teachers in Program-Group 2, MPCK performance was strongest in Chinese Taipei and Singapore, where approximately 75% of the future teachers sampled scored above the anchor point and almost all above the international mean. A small percentage of future teachers in Singapore in this program-group performed exceptionally well on the MPCK items compared to future teachers in all other countries and programs.

In programs preparing future teachers for both primary and lower-secondary grades, (Program-Group 3), future teachers in both the ALU and ALU plus programs in Norway were most successful. Their scale score means were at or above the anchor point. However, it was only in the ALU plus sample that at least half of the future teachers scored at or above the anchor point.

In programs preparing primary mathematics specialists, Program-Group 4, future teachers in Singapore achieved the highest mean MPCK score, and more than 80% scored at or above the MPCK anchor point. More than half of the future teachers in the samples in Germany and Poland also scored at or above the anchor point.

5.4.2 Future Lower-Secondary Teachers' Mathematics Knowledge

This section describes the mathematics knowledge of future lower-secondary teachers. It starts with MCK and concludes with MPCK. As with the previous section, to help readers understand the levels of knowledge reached by future teachers, we first describe the anchor points and then illustrate these with a small number of selected released items. We also provide summary tables and charts in order to facilitate international comparisons.

5.4.2.1 Anchor points for the lower-secondary MCK scale

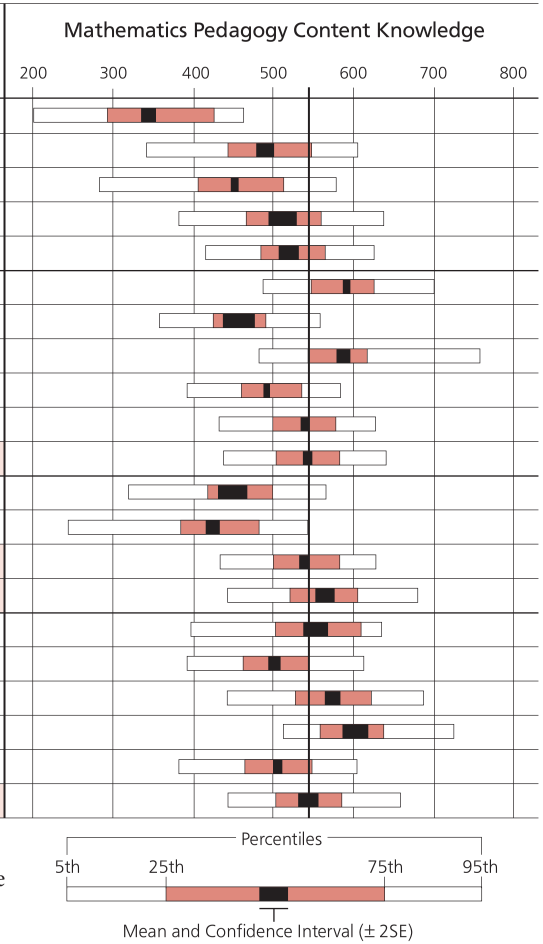
Two anchor points were selected for the lower-secondary MCK scale. Anchor Point 1 represents a lower level of performance and corresponds to a scale score of 490. Anchor Point 2 represents a higher level and corresponds to a scale score of 559.

- *Lower-secondary MCK Anchor Point 1:* future teachers of lower-secondary school mathematics who scored at (or above) Anchor Point 1 were likely to correctly answer items involving concepts related to whole numbers, integers, and rational numbers, and the associated computations. They were also likely to evaluate algebraic expressions correctly, and solve simple linear and quadratic equations, particularly those that can be solved by substitution or trial and error.

  These preservice teachers were generally familiar with standard geometric figures in the plane and space, and were able to identify and apply simple relations in plane geometry. They were also able to interpret and solve more complex problems about numbers, algebra, and geometry if the context or problem type was commonly taught in lower-secondary schools.

Exhibit 5.13: Future primary teachers' mathematics pedagogy content knowledge

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Percent at or above Anchor Point	(*SE*)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	506	0.0	0.6	(0.2)	345	(5)
	Germany	935	907	2.4	25.9	(2.0)	491	(5)
	Poland [a]	1,812	1,799	0.9	11.9	(1.3)	452	(2)
	Russian Federation [b]	2,266	2,260	0.2	31.6	(4.1)	512	(8)
	Switzerland [c]	121	121	0.0	31.6	(4.2)	519	(6)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	77.0	(1.3)	592	(2)
	Philippines	592	592	0.0	5.9	(1.6)	457	(10)
	Singapore	263	262	0.4	74.9	(2.5)	588	(4)
	Spain	1,093	1,093	0.0	17.5	(1.3)	492	(2)
	Switzerland	815	815	0.0	44.0	(1.5)	539	(2)
	United States † [d]	1,310	951	28.6	47.6	(1.7)	544	(3)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana [e]	86	86	0.0	6.2	(2.8)	448	(9)
	Chile [f]	657	654	0.4	4.9	(1.0)	425	(4)
	Norway (ALU) [g]	392	392	0.0	42.2	(2.9)	539	(3)
	Norway (ALU+) [g]	159	159	0.0	58.7	(3.8)	564	(6)
Group 4. Primary Mathematics Specialists	Germany	97	97	0.0	59.6	(3.4)	552	(7)
	Malaysia	576	574	0.4	23.4	(1.9)	503	(3)
	Poland [a]	300	300	0.0	67.3	(2.3)	575	(4)
	Singapore	117	117	0.0	81.1	(3.9)	604	(7)
	Thailand	660	660	0.0	26.4	(1.5)	506	(2)
	United States † [d]	191	132	33.2	41.4	(6.3)	545	(6)



Notes:

1. This table and chart must be read with awareness of the limitations annotated on page 134 of this chapter and denoted in the above by footnote letters.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. The solid vertical lines on the chart show the two anchor points (431 and 516).

Future teachers scoring at Anchor Point 1 were likely to have difficulty describing general patterns, solving multi-step problems with complex linguistic or mathematical relations, and relating equivalent representations of concepts. They tended to over-generalize concepts, and generally did not have a good grasp of mathematical reasoning. In particular, they found recognizing faulty arguments and justifying or proving conclusions challenging.

- *Lower-secondary MCK Anchor Point 2:* the future teachers who scored at Anchor Point 2 were likely to correctly do all the mathematics that could be done by a future teacher at Anchor Point 1. In addition, the future teachers at Anchor Point 2 were likely to correctly answer questions about functions (particularly linear, quadratic, and exponential), to read, analyze, and apply abstract definitions and notation, and to make and recognize simple arguments. They knew some definitions and theorems typically taught in tertiary-level courses, such as calculus, abstract algebra, and college geometry, and were generally able to apply them in straightforward situations.

  However, the future teachers scoring at Anchor Point 2 were unlikely to solve problems stated in purely abstract terms, or to work competently on foundational material, such as axiomatic systems. They were likely to make errors in logical reasoning (e.g., not attending to all conditions of definitions or theorems and confusing the truth of a statement with the validity of an argument), and they were unlikely to recognize valid proofs of more complex statements. Although the future teachers scoring at Anchor Point 2 could make some progress in constructing mathematical proofs, they were rarely successful at completing mathematical proofs.

Exhibit 5.14 shows two of the items used to test future lower-secondary teachers' abilities to apply school algebra; specifically, to solve story problems. Each item involves three numbers whose sum is 198. Future teachers with scores at or above Anchor Point 1 were likely to achieve success on the first item, that is, they had at least a 70% chance of getting this item correct.

Notice that in item MFC604A1, the numbers of marbles held by Peter and James are described as multiples of the number of marbles held by David. The problem can therefore be solved by setting up a simple linear equation with one unknown and one integer coefficient. In contrast, the second item has a more complex linguistic structure, making it less obvious which quantity to use as the base of the comparisons, an outcome that, in turn, leads to a somewhat more complex equation. Future teachers with scores at Anchor Point 1 were unlikely to achieve success on MFC604A2. Here, they had less than a 50% chance of responding correctly to the item. In contrast, those prospective teachers with scores at Anchor Point 2 had at least a 70% chance of answering item MFC604A2 correctly.

Exhibits 5.15 and 5.16 show MCK items that differ in content domains, item formats, and item difficulties. Both the multi-step geometry problem in Exhibit 5.15 and the straightforward combinatorics item in Exhibit 5.16 illustrate items that future teachers with MCK scores at Anchor Point 2 were unlikely to answer correctly.

5.4.2.2 MCK results by lower-secondary program-group

Exhibit 5.17 provides descriptive statistics for scores on the lower-secondary MCK survey by program-group. It also shows box plots of the distributions of scores, with MCK Anchor Point 1 (490) and Anchor Point 2 (559) marked on the display.

Exhibit 5.14: Constructed-response Items MFC604A1–A2,***

The following problems appear in a mathematics textbook for <lower secondary school>.

1. [Peter], [David], and [James] play a game with marbles. They have 198 marbles altogether. [Peter] has 6 times as many marbles as [David], and [James] has 2 times as many marbles as [David]. How many marbles does each boy have?
2. Three children [Wendy], [Joyce] and [Gabriela] have 198 zeds altogether. [Wendy] has 6 times as much money as [Joyce], and 3 times as much as [Gabriela]. How many zeds does each child have?

(a) Solve each problem.

Solution to Problem 1

Solution to Problem 2

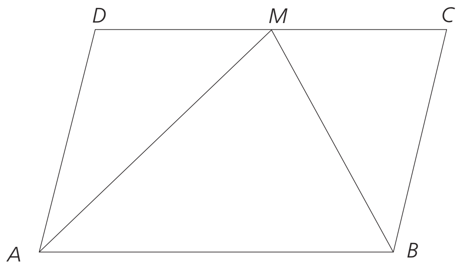
Notes:

* International average percent correct: 604A1 (72%), 604A2 (50%).

** Part (b) of this item assessing MPCK appears as Figure 5.19 later in this chapter.

*Exhibit 5.15: Constructed-response Item MFC704**

On the figure, ABCD is a parallelogram, $\angle BAD=60°$, *AM* and *BM* are angle bisectors of angles *BAD* and *ABC* respectively. If the perimeter of *ABCD* is 6 cm, find the sides of triangle *ABM*.



Write your answers on the lines below.

AB = ____________ cm

AM = ____________ cm

BM = ____________ cm

Note: * International average percent correct: full credit (32%), partial credit (25%).

As was the case for the distributions of MCK at the primary level, the future teachers' knowledge varied widely within and across countries. In the lower-secondary program-group, Program-Group 5, the difference between the highest and the lowest mean MCK scores was almost 200 points. In the lower- and upper-secondary Program-Group 6, the differences between the highest and the lowest mean MCK scores were even greater. However, distributions within the two program-groups also overlapped. Thus, even in the lower-scoring countries within each program-group, there were some future teachers who outperformed some future teachers in the higher-scoring countries.

The future lower-secondary teachers enrolled in programs leading to qualifications to teach up to Grade 10, that is, Program-Group 5, typically found the MCK items challenging. Only 3 of the 10 countries (Poland, Singapore, and Switzerland) had a

*Exhibit 5.16: Multiple-choice MCK Item MFC804**

A class has 10 students. If at one time, 2 students are to be chosen, and another time 8 students are to be chosen from the class, which of the following statements is true?

Check *one* box.

A.	There are more ways to choose 2 students than 8 students from the class.	☐
B.	There are more ways to choose 8 students than 2 students from the class.	☐
C.	The number of ways to choose 2 students equals the number of ways to choose 8 students.	☐
D.	It is not possible to determine which selection has more possibilities.	☐

Note: * International average percent correct: 35%.

mean score above the international mean. Even in the country with the highest mean score, no more than 40% of the future secondary teachers scored at or above Anchor Point 2.

In contrast, future teachers in 7 of the 12 countries preparing to teach students in the lower- and upper-secondary grades (Program-Group 6) scored, on average, above the international mean. The performance of the future teachers in Chinese Taipei was particularly strong, with about 96% of them scoring at or above Anchor Point 2. In all countries except Botswana, some future teachers reached Anchor Point 2.

5.4.2.3 Lower-secondary anchor point for MPCK

As was the case at the primary level, the relatively small number of items measuring mathematics pedagogical content knowledge meant that only one anchor point for MPCK was defined at the lower-secondary level. It corresponds to a scale score of 509.

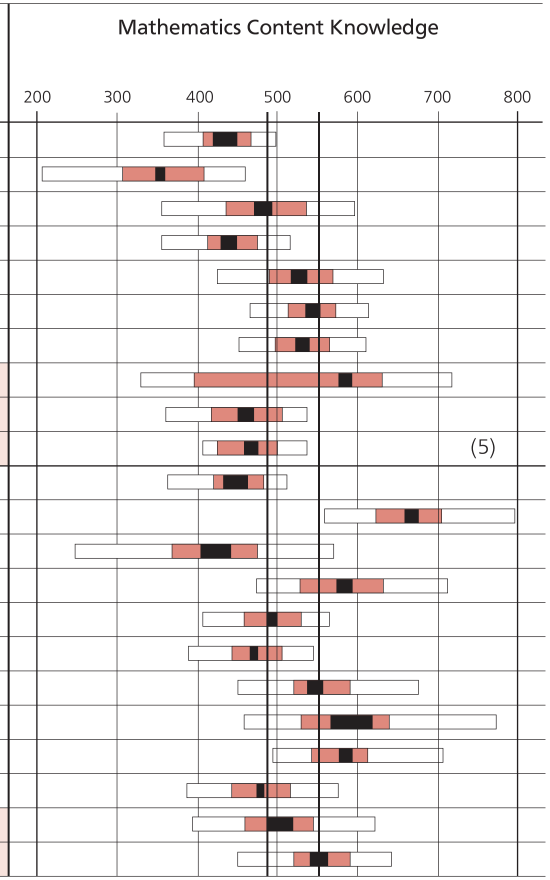
The future lower-secondary teachers who scored at (or above) this point were likely to have some knowledge of the lower-secondary curriculum and of planning for instruction. For instance, they were likely to identify prerequisites for teaching a derivation of the quadratic formula, and they could generally determine consequences of moving the concept of square root from the lower-secondary to the upper-secondary school mathematics curriculum. They were likely to show some skill in enacting (teaching) school mathematics. Future teachers at this level were able to evaluate students' mathematical work correctly in some situations. For example, they could generally determine if a student's diagram satisfied certain given conditions in geometry, and to recognize a student's correct argument about divisibility of whole numbers.

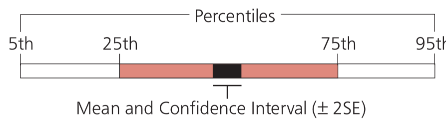
The future teachers at this anchor point were also likely to successfully analyze students' errors when the students' work involved a single step or short explanations, for example, identifying an error in a histogram. They struggled, however, to identify or analyze errors in more complex mathematical situations. For instance, they could not consistently apply a rubric with descriptions of three performance levels to evaluate students' solutions to a problem about linear and non-linear growth.

In general, the future teachers' own depth of mathematical understanding seemed to influence their ability to interpret students' thinking or to determine appropriate responses to students. Because future teachers at this level seem to lack a well-developed concept of the meaning of a valid mathematical argument, they frequently were unable to evaluate some invalid arguments. In particular, they generally did not recognize that examples are not sufficient to constitute a proof.

Exhibit 5.17: Future lower-secondary teachers' mathematics content knowledge

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Percent at or above Anchor Point 1 (*SE*)	Percent at or above Anchor Point 2 (*SE*)	Scaled Score: Mean (*SE*)
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana [a]	34	34	0.0	6.0 (4.2)	0.0	436 (7)
	Chile [b]	746	741	0.6	1.2 (0.4)	0.0	354 (3)
	Germany	408	406	0.3	53.5 (3.4)	12.6 (2.2)	483 (5)
	Philippines	733	733	0.0	14.0 (3.0)	0.2 (0.1)	442 (5)
	Poland [c]	158	158	0.0	75.6 (3.5)	34.7 (3.2)	529 (4)
	Singapore	142	142	0.0	86.9 (3.1)	36.6 (4.3)	544 (4)
	Switzerland [d]	141	141	0.0	79.7 (3.4)	26.7 (3.2)	531 (4)
	Norway (ALU) [e]	356	344	3.9	19.3 (1.6)	0.8 (0.4)	461 (5)
	Norway (ALU +) [e]	151	148	1.9	36.1 (3.7)	2.3 (1.4)	435 (3)
	United States † [f]	169	121	32.7	33.5 (2.2)	2.1 (1.3)	468 (4)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	19	0.0	21.1 (7.4)	0.0	449 (8)
	Chinese Taipei	365	365	0.0	98.6 (0.8)	95.6 (1.0)	667 (4)
	Georgia [g]	78	78	0.0	18.2 (4.4)	5.0 (2.6)	424 (9)
	Germany	363	362	0.1	93.4 (1.5)	62.1 (2.9)	585 (4)
	Malaysia	389	388	0.2	57.1 (2.3)	6.9 (0.9)	493 (2)
	Oman	268	268	0.0	37.1 (2.7)	1.8 (0.6)	472 (2)
	Poland	140	139	0.8	85.7 (2.6)	35.7 (2.7)	549 (4)
	Russian Federation [h]	2,141	2,139	0.1	88.8 (1.7)	61.1 (4.3)	594 (13)
	Singapore	251	251	0.0	97.6 (1.0)	62.9 (2.6)	587 (4)
	Thailand	652	652	0.0	41.0 (1.5)	8.4 (1.1)	479 (2)
	Norway (PPU & Masters) [e]	65	65	0.0	57.8 (7.9)	16.0 (4.6)	503 (8)
	United States † [f]	438	354	21.3	87.1 (2.0)	44.5 (3.9)	553 (5)





Notes:

1. This table and chart must be read with awareness of the limitations annotated on page 135 of this chapter and denoted in the above by footnote letters.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. The solid vertical lines on the chart show the two anchor points (431 and 516).

Exhibit 5.18 shows a complex multiple-choice item designed to test future teachers' skill in enacting school mathematics, in this case evaluating three students' arguments about divisibility (Items MFC709A, B, and C). Future teachers with MPCK scores at or above the anchor point were likely to recognize Kate's valid argument. However, even future teachers scoring at the MPCK anchor point had difficulty recognizing that examples are not sufficient to constitute a proof, as in Leon's argument, or when properties are incorrectly applied, as in Maria's answer.

Exhibit 5.18: Complex multiple-choice MPCK Items MFC709A–B, ***

Some <lower-secondary school> students were asked to prove the following statement:
When you multiply 3 consecutive natural numbers, the product is a multiple of 6.
Below are three responses.

[Kate's] answer

A multiple of 6 must have factors of 3 and 2.
If you have three consecutive numbers, one will be a multiple of 3.
Also, at least one number will be even and all even numbers are multiples of 2.
If you multiply the three consecutive numbers together the answer must have at least one factor of 3 and one factor of 2.

[Leon's] answer

1 x 2 x 3 = 6

2 x 3 x 4 = 24 = 6 x 4

4 x 5 x 6 = 120 = 6 x 20

6 x 7 x 8 = 336 = 6 x 56

[Maria's] answer

n is any whole number

$n \times (n + 1) \times (n + 2) = (n^2 + n) \times (n + 2)$
$= n^3 + n^2 + 2n^2 + 2n$

Cancelling the n's gives 1 + 1 + 2 + 2 = 6

Determine whether each proof is valid. Check *one* box in *each* row.

	Valid	Not valid
A. [Kate's] proof	☐	☐
B. [Leon's] proof	☐	☐
C. [Maria's] proof	☐	☐

Notes:
* International average percent correct: A (75%); B (46%).
** For the full item, see the secondary released items on the TEDS-M website

Exhibit 5.19 shows an MPCK item that asked future teachers to explain why one story problem is likely to be more difficult than another for lower-secondary students. Future teachers whose scores were below the MPCK anchor point were unlikely to achieve success on this item. Even future teachers who had been able to solve both Problems 1 and 2 correctly (see Exhibit 5.14) struggled with this related problem tapping mathematics pedagogical content knowledge.

5.4.2.4 MPCK results by program-group

Exhibit 5.20 gives descriptive statistics for the mathematics pedagogical content knowledge of future teachers who completed the lower-secondary surveys. The exhibit also shows box plots of the distributions, with the MPCK anchor point (509) marked with a vertical line.

*Exhibit 5.19: Constructed-response MPCK Item MFC604B from the lower-secondary survey**, **

(b) Typically, Problem 2 is more difficult than Problem 1 for <lower secondary> students. Give one reason that might account for the difference in difficulty level.

Notes:
* International average percent correct: 39%.
** See Exhibit 5.14 for the item stimulus.

Four of the 10 countries in Program-Group 5 achieved mean scores above the international mean whereas 6 of the 12 countries in Program-Group 6 achieved this benchmark. In every country, some future teachers scored at or above the MPCK anchor point. The future teachers in Switzerland and Singapore achieved the highest mean MPCK scores among those teachers preparing to teach students in the lower-secondary grades (i.e., Program-Group 5); more than 60% of these teachers in the two countries scored at or above the MPCK anchor point.

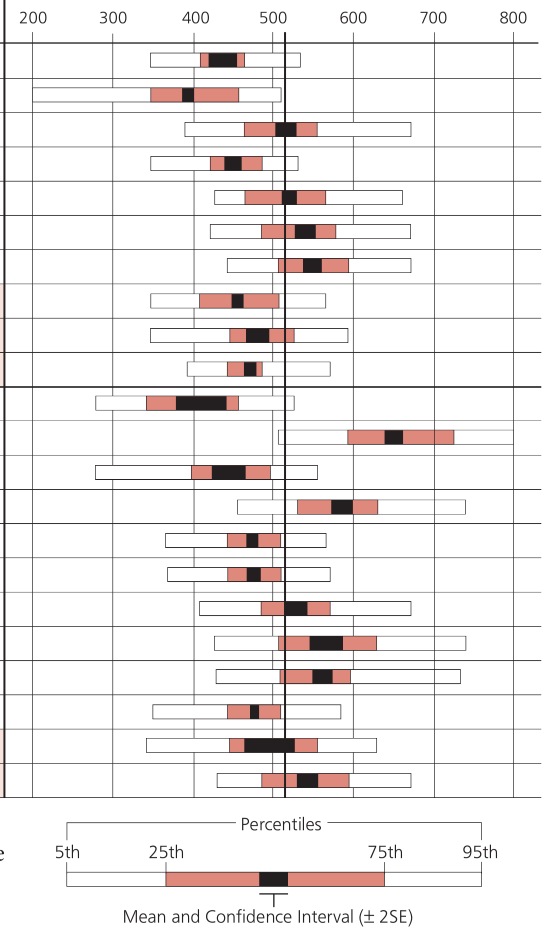
Among the future teachers preparing to teach lower- and upper-secondary grades (i.e., Program-Group 6), the performance of the future teachers from Chinese Taipei was particularly strong, with more than 93% of the sample achieving scores at or above the MPCK anchor point. In Germany, Poland, the Russian Federation, Singapore, and the United States, the majority of the future teachers also scored at or above the MPCK anchor point.

5.5 Conclusion

It is natural to wonder what accounts for differences in knowledge across and within countries. The answer to this question requires additional analyses, and is beyond the scope of this report. For each participating unit—a country or an institution, for example—the results of TEDS-M serve as baseline data from which to carry out further investigation. For instance, content experts might choose to look at the descriptions of the anchor points for MCK and MPCK and the percentage of the future teachers graduating from their unit who reach each anchor point. They might then want to study how changes in curricula may lead to improved performance. Policymakers might want to investigate policies that can be implemented to encourage more talented secondary school graduates to select teaching as a career. Or they might want to look at whether extending the duration of teacher preparation programs can lead to higher scores on MCK and MPCK scales.

Exhibit 5.20: Future secondary teachers' mathematics pedagogy content knowledge

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Percent at or above Anchor Point	(*SE*)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana [a]	34	34	0.0	8.9	(5.1)	436	(9)
	Chile [b]	746	741	0.6	5.7	(1.1)	394	(4)
	Germany	408	406	0.3	52.5	(4.6)	515	(6)
	Philippines	733	733	0.0	12.3	(2.0)	450	(5)
	Poland [c]	158	158	0.0	49.7	(3.1)	520	(5)
	Singapore	142	142	0.0	65.9	(4.2)	539	(6)
	Switzerland [d]	141	141	0.0	70.9	(3.8)	549	(6)
	Norway (ALU) [e]	356	344	3.9	20.9	(2.2)	455	(4)
	Norway (ALU +) [e]	151	148	1.9	30.8	(4.2)	480	(6)
	United States † [f]	169	121	32.7	16.7	(3.1)	471	(4)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	19	0.0	5.3	(7.4)	409	(16)
	Chinese Taipei	365	365	0.0	93.3	(1.5)	649	(5)
	Georgia [g]	78	78	0.0	18.2	(3.9)	443	(10)
	Germany	363	362	0.1	80.3	(2.7)	586	(7)
	Malaysia	389	388	0.2	27.9	(2.5)	472	(3)
	Oman	268	268	0.0	29.8	(2.9)	474	(4)
	Poland	140	139	0.8	62.2	(4.7)	528	(6)
	Russian Federation [h]	2,141	2,139	0.1	71.0	(3.1)	566	(10)
	Singapore	251	251	0.0	75.3	(3.1)	562	(6)
	Thailand	652	652	0.0	28.4	(1.9)	476	(2)
	Norway (PPU & Masters) [e]	65	65	0.0	41.0	(6.8)	494	(16)
	United States † [f]	438	354	21.3	61.0	(3.0)	542	(6)



Notes:

1. This table and chart must be read with awareness of the limitations annotated on page 135 of this chapter and denoted in the above by footnote letters.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. The solid vertical lines on the chart show the two anchor points (431 and 516).

References

An, S., Kulm, G., & Wu, Z. (2004). The pedagogical content knowledge of middle school mathematics teachers in China and the U.S. *Journal of Mathematics Teacher Education*, *7*, 145–172.

Baumert, J., Kunter, M., Blum, W., Brunner, M., Voss, T., Jordan, A., … Tsai, Y-M. (2010). Teachers' mathematical knowledge, cognitive activation in the classroom, and student progress. *American Educational Research Journal*, *47*(1), 133–180.

Carpenter, T. P., Fennema, E. Franke, M. L., Levi, L., & Empson, S. E. (1999). *Children's mathematics: Cognitively guided instruction*. Westport, CT: Heinemann.

Committee on the Study of Teacher Preparation Programs in the United States. (2010). *Preparing teachers: Building evidence for sound policy*. Washington, DC: National Research Council, the National Academies. Available online at http://www.nap.edu/catalog.php?record_id=12882

Conference Board of the Mathematical Sciences. (2001). *The mathematical education of teachers: Issues in mathematics education* (Vol. 11). Washington, DC: American Mathematical Society.

Even, R., & Ball, D. L. (Eds.). (2009). *The professional education and development of teachers of mathematics: The 15th ICMI study* (New ICMI Study Series, 11). New York, NY: Springer.

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

Hill, H. C., & Ball, D. L. (2004). Learning mathematics for teaching: Results from California's mathematics professional development institutes. *Journal of Research in Mathematics Education*, *35*, 330–351.

Hill, H. C., Rowan, B., & Ball, D. L. (2005). Effects of teachers' mathematical knowledge for teaching on student achievement. *American Educational Research Journal*, *42*(2), 371– 406.

Mullis, I. V. S., Martin, M. O., Ruddock, G. J., O'Sullivan, C. Y., Arora, A., & Erberber, E. (2007). *TIMSS 2007 assessment frameworks*. Chestnut Hill, MA: Boston College.

Pepin, B. (1999). Existing models of knowledge in teaching: Developing an understanding of the Anglo/American, the French and the German scene. In B. Hudson, F. Buchberger, P. Kansanen, & H. Seel (Eds.), *Didaktik/Fachdidaktik as Science(s) of the Teaching Profession?* (pp. 49–66). Umeå, Sweden: TNTEE Publications.

Schmidt, W. H., Blöemeke, S., & Tatto, M. T. (Eds.). (2011). *Teacher education matters: A study of middle school mathematics teacher preparation in six countries*. New York, NY: Teachers College Press.

Schmidt, W., Tatto, M. T., Bankov, K., Blomeke, S., Cedillo, T., Cogan, L., … Schwille, J. (2007, December). *The preparation gap: Teacher education for middle school mathematics in six countries* (MT21 report) (NSF REC 0231886/January 2003). East Lansing, MI: Michigan State University. Available online at http://usteds.msu.edu/MT21Report.pdf

Senk, S. L., Peck, R., Bankov, K., & Tatto, M. T. (2008). *Conceptualizing and measuring mathematical knowledge for teaching: Issues from TEDS-M, an IEA cross-national study*. Paper prepared for Topic Study Group 27 (mathematical knowledge for teaching) of the 11th International Congress on Mathematical Education, Monterrey, Mexico, July 6–13, 2008. Available online at http://tsg.icme11.org/document/get/746

Shulman, L. (1987). Knowledge and teaching: Foundations of the new reform. *Harvard Educational Review*, *57*, 1–22.

Tatto, M. T. (2012). *TEDS-M 2008 technical report*. Amsterdam, the Netherlands: International Association for Educational Achievement (IEA).

Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). T*eacher Education and Development Study in Mathematics (TEDS-M): Conceptual framework*. Amsterdam, the Netherlands: International Association for Educational Achievement (IEA).

CHAPTER 6:

BELIEFS ABOUT MATHEMATICS AND MATHEMATICS LEARNING

6.1 Chapter Overview

As noted in Chapter 1, one of the key research questions for TEDS-M was this one: What beliefs about the nature of mathematics and about teaching and learning mathematics do future teachers hold at the end of their preparation? While content knowledge and pedagogical knowledge are acknowledged to be essential for successful teaching, there is also widespread agreement that the beliefs held by teachers and students are an important influence on teaching and learning. However, there is little conclusive evidence that beliefs can be effectively influenced by teacher preparation or that they are an intrinsic characteristic of those individuals who become teachers (Tatto & Coupland, 2003).

In his chapter written for the *Second Handbook of Research on Mathematics Teaching* (Lester, 2007), Randolph Philipp focused on what he termed "teachers' orientations." An orientation refers to a pattern of beliefs that a teacher may hold about mathematics and mathematics teaching. Philipp (2007), building on work carried out by Thompson (1992) and by Thompson, Philipp, Thompson, and Boyd (1994), identified two orientations—conceptual and calculational—to describe important dimensions on which teachers are known to differ. In Philipp's (2007) words, a teacher with a conceptual orientation is one whose actions

> are driven by an image of a system of ideas and ways of thinking she intends her students to develop; an image of how these ideas and ways of thinking can be developed; ideas about features of materials, activities and expositions and the students' engagement with them that can orient students' attention in productive ways; and an expectation and insistence that students will be intellectually engaged in tasks and activities. (p. 303)

The actions of a teacher with a calculational orientation, however,

> are driven by a fundamental image of mathematics as the application of calculations and procedures for deriving numerical results. Associated with a calculational orientation is a tendency to speak exclusively in the language of number and numerical operations, a predisposition to cast problem solving as producing a numerical solution, and a tendency to disregard context … (p. 304)

It is reasonable to expect that teachers holding these different patterns of belief will engage in different classroom practices, and Philipp cites research evidence (Thompson et al., 1994) suggesting that they do. The extent to which these different practices impact on student outcomes is far from clear, and what evidence there is tends to come from quasi-experimental or naturalistic studies, such as that by Staub and Stern (2002). They compared achievement gains made by Grade 3 students taught by teachers holding a cognitive-constructivist orientation (which focuses strongly on concepts and holds that understanding is based on restructuring one's own prior knowledge) with those made by students whose teachers held a direct-transmission view (which focuses more on acquiring basic numerical facts and mastering routines and procedures). They found that

> students whose Grade 3 teachers had a stronger cognitive constructivist orientation … displayed higher achievement gains in demanding mathematical word problems than did students whose Grade 3 teachers had less of a cognitive constructivist view, subscribing instead to pedagogical content beliefs that are consistent with a direct-transmission view of learning and teaching. (p. 354)

Interestingly, Staub and Stern (2002) also found that students taught by teachers with a cognitive-constructivist orientation achieved as well as or better at routine tasks involving mathematical facts and procedures than did students of teachers whose orientation was directed more toward such tasks.

Evidence such as this suggests that the beliefs about mathematics and mathematics learning that beginning teachers carry with them may influence how they teach, and subsequently may influence how their students learn. For this reason, TEDS-M resolved to gather data about three aspects of future teachers' mathematics-related beliefs:

1. Beliefs about the nature of mathematics;
2. Beliefs about learning mathematics; and
3. Beliefs about mathematics achievement.

Although the measures developed for TEDS-M might be seen as loosely related to the calculational versus conceptual and the direct transmission versus cognitive-constructivist distinctions described above, they should not be seen as equivalent to them.

The development of the TEDS-M questionnaire scales was informed by work done as part of the Teaching and Learning to Teach Study at Michigan State University (Deng, 1995; Tatto, 1996, 1998, 2003), and resulted in five belief scales covering the above three areas. The items used to measure these five dimensions of beliefs about mathematics and mathematics learning were drawn from a number of studies, including one by Deng (1995), the feasibility study for TEDS-M (Schmidt et al., 2007), and several studies by Tatto (1996, 1998, 1999, 2003).

6.2 Beliefs about the Nature of Mathematics

The items included in this area explored how the future teachers who participated in TEDS-M perceived mathematics as a subject (e.g., mathematics as formal, structural, procedural, or applied). The items are based on work by Grigutsch, Raatz, and Törner, (1998) and others. Two scales were developed: mathematics as a set of rules and procedures, and mathematics as a process of inquiry.

6.2.1 Mathematics as a Set of Rules and Procedures

Respondents who score highly on this scale tend to see mathematics as a set of procedures to be learned, with strict rules as to what is correct and what is incorrect. They typically agree with statements such as the following ones, included in the scale:

1. Mathematics is a collection of rules and procedures that prescribe how to solve a problem.
2. Mathematics involves the remembering and application of definitions, formulas, mathematical facts, and procedures.
3. When solving mathematical tasks, you need to know the correct procedure else you would be lost.
4. Fundamental to mathematics is its logical rigor and precision.
5. To do mathematics requires much practice, correct application of routines, and problem solving strategies.
6. Mathematics means learning, remembering, and applying.

6.2.2 Mathematics as a Process of Enquiry

Respondents who score highly on this scale see mathematics as a means of answering questions and solving problems. They see mathematical procedures as tools of enquiry, as means to an end, but not as ends in themselves. They typically agree with statements such as the following ones that feature in the scale:

1. Mathematics involves creativity and new ideas.
2. In mathematics many things can be discovered and tried out by oneself.
3. If you engage in mathematical tasks, you can discover new things (e.g., connections, rules, concepts).
4. Mathematical problems can be solved correctly in many ways.
5. Many aspects of mathematics have practical relevance.
6. Mathematics helps solve everyday problems and tasks.

Respondents are not forced to choose between the two sets of beliefs about the nature of mathematics; it is quite possible for them to endorse both sets of propositions, that is, to believe that mathematics is a set of rules and procedures and a process of enquiry. In constructing the scales, however, the TEDS-M research team expected that future teachers would lean toward one or other view of the nature of mathematics, and that the two scales would be negatively correlated. In general, this was the case.

6.3 Beliefs about Learning Mathematics

In this section, we focus on the appropriateness of particular instructional activities, questions about students' cognitive processes, and questions about the purposes of mathematics as a school subject. The TEDS-M research team developed two belief-related scales: learning mathematics through following teacher direction, and learning mathematics through active involvement.

6.3.1 Learning Mathematics through Following Teacher Direction

Respondents who score highly on this scale tend to see mathematics learning as being heavily teacher-centered: the student's role is to follow instructions from the teacher, and through doing so learn mathematics. These respondents typically agree with statements such as these ones included in the scale:

1. The best way to do well in mathematics is to memorize all the formulas.
2. Pupils need to be taught exact procedures for solving mathematical problems.
3. It doesn't really matter if you understand a mathematical problem, if you can get the right answer.
4. To be good in mathematics you must be able to solve problems quickly.
5. Pupils learn mathematics best by attending to the teacher's explanations.
6. When pupils are working on mathematical problems, more emphasis should be put on getting the correct answer than on the process followed.
7. Non-standard procedures should be discouraged because they can interfere with learning the correct procedure.
8. Hands-on mathematics experiences aren't worth the time and expense.

6.3.2 Learning Mathematics through Active Involvement

Respondents who score highly on this scale tend to see mathematics learning as being active learning: students must do mathematics, conduct their own enquiries, and develop ways to solve problems if their mathematics learning is to be effective. These respondents usually agree with statements such as the following, included in the scale:

1. In addition to getting a right answer in mathematics, it is important to understand why the answer is correct.
2. Teachers should allow pupils to figure out their own ways to solve mathematical problems.
3. Time used to investigate why a solution to a mathematical problem works is time well spent.
4. Pupils can figure out a way to solve mathematical problems without a teacher's help.
5. Teachers should encourage pupils to find their own solutions to mathematical problems even if they are inefficient.
6. It is helpful for pupils to discuss different ways to solve particular problems.

As with the scales reflecting beliefs about the nature of mathematics, respondents are not forced to choose between the two sets of beliefs about mathematics learning, and can thus endorse both sets of propositions, believing that mathematics is learned both through active student involvement and by following teacher directions. Our expectation was that future teachers would lean toward one or the other view of learning, and that the two scales would be negatively correlated. This proved to be the case.

6.4 Beliefs about Mathematics Achievement

6.4.1 Mathematics as a Fixed Ability

Respondents who scored highly on this scale tended to see mathematics achievement as heavily dependent on the ability of the student: school mathematics is something that is accessible to some students, and relatively inaccessible to others. For those holding strongly to these beliefs, a key element of mathematics teaching is finding out which students can learn mathematics well and which cannot. These respondents typically agree with statements such as the following ones, included in the scale:

1. Since older pupils can reason abstractly, the use of hands-on models and other visual aids becomes less necessary.
2. To be good at mathematics, you need to have a kind of "mathematical mind."
3. Mathematics is a subject in which natural ability matters a lot more than effort.
4. Only the more able pupils can participate in multi-step problem-solving activities.
5. In general, boys tend to be naturally better at mathematics than girls.
6. Mathematical ability is something that remains relatively fixed throughout a person's life.
7. Some people are good at mathematics and some aren't.
8. Some ethnic groups are better at mathematics than others.

6.5 Scaling of Beliefs

Of the five scales developed, two—*mathematics as a process of enquiry* and *learning mathematics through active involvement*—are largely consistent with the orientations previously described as conceptual (Philipp, 2007) and as cognitive-constructionist (Staub & Stern, 2002).

The next two scales—*mathematics as a set of rules and procedures* and *learning mathematics through following teacher direction*—are more consistent with the orientations previously described as calculational (Philipp, 2007) and direct-transmission (Staub & Stern, 2002).

The fifth scale, *mathematics as a fixed ability*, is not conceptually related to these orientations. However, it reflects a view of mathematics learning that, if evident in teachers' actions, is likely to result in lower expectations for many students. This view is therefore one that experts in mathematics education discourage.

The TEDS-M team used two methods to develop the scales:

- Item response theory (IRT) scales, for documenting relationships among measures;
- Percent endorsement, for descriptive display.

6.5.1 IRT Scales for Documenting Relationships among Measures

Using IRT to scale the survey items allowed us to investigate the relationships among beliefs, mathematics content knowledge, and mathematics pedagogy content knowledge. For each belief (survey 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 greater than 10 indicate responses that predominantly agree with the statements; scores below 10 indicate responses that predominantly disagree with the statements.

Effort was made during development of the scales to obtain the best possible matching of the score to the underlying attribute. The scales are particularly suitable for quantifying relationships among the beliefs or between beliefs and scores on other similarly constructed TEDS-M scales, in particular, the standardized scores for mathematics content knowledge and mathematics pedagogy content knowledge.

6.5.2 Percent Endorsement for Descriptive Display

Because IRT scores are not easily interpretable in terms of the extent of agreement or disagreement with the statements that define the scales, we used a second procedure to develop measures that would be easier to interpret and to present economically (i.e., in descriptive displays). An account of this procedure follows.

In order to respond to each statement, respondents were asked to choose from six response alternatives:

1. Strongly disagree
2. Disagree
3. Slightly disagree
4. Slightly agree
5. Agree
6. Strongly agree.

We considered Responses 5 and 6 (“agree” and “strongly agree”) to be endorsements of the respective statements, and Responses 1 through 4 (“strongly disagree” through to “slightly agree”) as failing to endorse statements. We acknowledge that a case could be made for including slightly agree as an endorsement, but we considered it at best a weak or qualified endorsement, and so excluded it.

For any group of respondents, the proportion of responses endorsing the statements is presented in this report as a measure of the group’s endorsement of the belief. If 90% of responses fell into the agree and strongly agree categories, the group responses indicated strong support for the belief; if only 10 or 20% of responses fell into these categories, the belief had little support from the group. Display of summary data in this form makes explicit just how much countries and groups within countries differ in the extent to which they endorse the beliefs measured.

6.6 Results

6.6.1 IRT Scales

Descriptive statistics for the IRT scales are presented by program-group, within each country, in Exhibits A6.1 through A6.5 (for future primary teachers), Exhibits A6.6 through A6.10 (for future lower-secondary teachers), and Exhibits A6.11 through A6.15 (for teacher educators). All of these exhibits appear in Appendix A.

Scrutiny of these exhibits allowed us to make a number of generalizations about the data. The statement expressing beliefs most consistent with the conceptual and cognitive-constructivist views of mathematics learning (mathematics is a process of enquiry; learning mathematics requires active involvement) attracted much greater support than the statements expressing beliefs most consistent with the conceptual and calculational views of mathematics learning (mathematics is a set of rules and procedures; learning mathematics requires following teacher direction).

This pattern was common across countries, but not universal. The latter two beliefs were more prevalent than the former two in Georgia (the country where the range of beliefs was also greatest), the Philippines, Malaysia, and, to some extent, Botswana and Thailand.

Differences between patterns of response for the future primary teachers and for the future lower-secondary teachers were not easy to discern, but we could tell they were relatively small. In order to facilitate discernment of such patterns, we developed a set of descriptive charts, which we discuss in the following paragraphs.

6.6.2 Descriptive Displays

For any group of respondents (e.g., teacher educators in a particular country, future teachers in primary programs, etc.), percentage of responses provided a measure of the extent to which these groups endorsed the various scale statements. Thus, in Germany, of the responses received from teacher educators in relation to the six statements forming the mathematics as a set of rules and procedures scale, 27.8% (with a standard error of 1.6%) were categorized as endorsements. In contrast, 73.4% of responses from the German teacher educators endorsed the six statements forming the mathematics as a process of enquiry scale (standard error, 1.9%). Thus, we can infer that German teacher educators give relatively strong endorsement to mathematics as a process of enquiry and only limited support to mathematics as a set of rules and procedures.

Exhibit 6.1 provides a detailed breakdown of the extent (in percentages and standard errors) to which teacher educators, future primary teachers, and future lower-secondary teachers endorsed each of the five beliefs scales. The data for the future primary teachers and future lower-secondary teachers are further broken down according to program-groups (the level of the education system at which these sets of teachers would be qualified to teach mathematics on graduating; see Section 2.2 of Chapter 2), as was done for the summary data on mathematics content knowledge and mathematics pedagogy content knowledge reported in Chapters 4 and 5.

Exhibits 6.2 through 6.6, which follow, present essentially the same information in graphic form, but reorganized by country, to allow readers to see the extent to which the teacher educators' and the future teachers' beliefs were consistent within countries. When interpreting the results presented in Exhibits 6.1 to 6.6 and our discussion of them, bear in mind the following annotations on the data for the listed countries. Although the patterns displayed in these figures are clear, there are sampling limitations that place constraints on the extent to which the data can be considered to represent national aggregates.

Limitation annotations for the data in Exhibits 6.1 to 6.8

a. *Botswana:* the sample sizes were small but arose from censuses of small populations.

b. *Chile:* the combined participation rates for future teachers were between 60% and 75%. The participation rate for teacher educators did not meet IEA standards, hence the red shading in some of the exhibits.

c. *Germany:* the participation rate for teacher educators did not meet IEA standards, hence the red shading in some of the exhibits.

d. *Malaysia:* the participation rate for teacher educators did not meet IEA standards, hence the red shading in some of the exhibits.

e. *Poland:* reduced coverage—institutions with consecutive programs only were not covered. The combined participation rate for future teachers (primary and lower-secondary) was between 60 and 75%.

f. *Russian Federation:* reduced coverage—secondary pedagogical institutions were excluded. An unknown number of the future lower-secondary teachers surveyed had previously qualified to become primary teachers.

g. *Switzerland:* the participation rate for teacher educators did not meet IEA standards, hence the red shading in some of the exhibits. The only institutions included were those where German is the primary language of use and instruction.

h. *United States:* reduced coverage—public institutions only. Exceptions were made to accept data from institutions where inclusion of only one additional participant would have brought the response rate to above the 50% threshold. The combined participation rates for both the primary and lower-secondary future teachers were between 60 and 75%. Both the primary and lower-secondary surveys contained records that were completed using a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Data on beliefs were not obtained from these respondents (approximately 21% percent of each survey sample). Bias may therefore arise in the data because of the number of individuals who did not receive and complete the full questionnaire.

i. *Norway:* the combined participation rate was between 60 and 75% for the future primary teachers and 58% for the future lower-secondary teachers. Data were accepted from one institution because the inclusion of only one additional participant would have brought the response rate to above the 50% threshold. Program-types ALU and ALU plus mathematics are reported separately because the two populations partly overlap; data from these program types cannot therefore be aggregated. These figures do not represent national aggregates, hence the red shading in some of the exhibits.

Exhibit 6.1: Beliefs about mathematics and mathematics learning: percent of statements endorsed, by respondent type within country

			Mathematics as a Set of Rules and Procedures		Mathematics as a Process of Enquiry		Learn Mathematics by Following Teacher Direction		Learn Mathematics through Active Involvement		Mathematics as a Fixed Ability	
Country	Respondent Type	*N*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Botswana[a]	Teacher educators	42	74.3	4.1	85.1	3.7	28.4	3.2	79.0	3.7	30.2	3.9
	Lower secondary (Grade 10 max.)	34	74.2	3.7	86.3	3.1	27.5	2.6	68.8	3.7	39.8	4.0
	Primary/sec. (Grade 10 max.)	86	78.6	2.1	87.3	2.2	22.5	1.9	76.6	2.2	35.7	2.1
	Secondary (Grade 11+)	19	74.6	6.5	80.7	3.7	26.3	4.3	76.7	4.3	34.6	4.1
Chile[b]	Teacher educators	383	44.8	1.3	87.5	1.1	14.0	0.9	85.8	1.1	10.2	0.8
	Lower secondary (Grade 10 max.)	714	60.6	1.2	77.1	1.2	23.4	0.8	80.5	1.0	18.4	0.9
	Primary/sec. (Grade 10 max.)	638	56.5	1.0	78.4	0.8	21.2	0.8	81.4	1.0	16.9	0.6
Chinese Taipei	Teacher educators	195	53.2	3.6	79.3	4.8	8.0	1.1	85.0	1.3	15.4	3.7
	Secondary (Grade 11+)	365	56.3	1.1	77.6	1.0	8.9	0.6	80.3	0.8	20.1	1.0
	Primary (Grade 6 max.)	923	55.7	1.2	75.4	0.9	8.1	0.4	75.6	0.9	19.1	0.6
Georgia	Teacher educators	62	83.9	2.8	88.5	2.0	31.7	2.7	83.8	2.0	45.7	3.3
	Lower primary (Grade 4 max.)	505	65.6	1.6	41.0	1.3	40.4	1.3	52.2	1.3	46.7	1.4
	Secondary (Grade 11+)	78	69.9	3.2	54.8	3.3	34.3	2.0	62.1	4.4	44.8	3.0
Germany[c]	Teacher educators	446	27.8	1.6	73.4	1.9	3.7	0.3	84.9	2.8	5.6	0.2
	Lower primary (Grade 4 max.)	886	34.0	1.7	56.3	1.4	6.2	0.5	75.8	1.1	11.4	0.6
	Lower secondary (Grade 10 max.)	403	25.4	2.5	74.1	2.0	5.7	1.1	76.7	2.1	6.1	0.9
	Primary mathematics specialists	97	21.1	3.2	80.2	2.9	3.8	1.0	81.5	4.1	7.1	1.5
	Secondary (Grade 11+)	359	24.2	1.0	78.7	1.5	4.4	0.5	84.9	1.2	6.3	0.7
Malaysia[d]	Teacher educators	251	74.4	1.6	89.6	1.6	33.3	1.5	74.4	1.6	40.5	2.4
	Primary specialists	563	77.9	1.2	86.9	1.1	42.4	1.2	61.0	1.1	45.5	1.0
	Secondary (Grade 11+)	386	73.8	1.5	77.9	1.6	40.2	1.4	62.2	1.4	47.2	1.7
Norway[i]	ALU (primary/secondary)	741	39.4	1.1	68.6	1.1	4.6	0.3	70.9	0.9	10.0	0.5
	ALU+ (primary/secondary)	303	33.6	1.9	83.0	1.3	3.0	0.3	77.1	1.3	6.5	0.6
	PPU & Master’s (secondary)	64	33.8	3.4	74.5	2.6	3.0	0.9	67.2	2.7	8.3	0.9
Oman	Teacher educators	75	66.8	3.1	86.8	2.1	25.1	2.0	75.2	2.5	36.5	2.9
	Secondary (Grade 11+)	267	70.9	1.1	88.3	1.0	28.9	1.1	73.9	1.4	31.7	1.5
Philippines	Teacher educators	583	89.2	1.3	89.0	3.5	37.9	3.0	76.6	1.5	36.2	2.1
	Lower secondary (Grade 10 max.)	730	88.6	0.9	88.0	1.9	42.2	1.9	73.2	1.6	45.1	2.0
	Primary (Grade 6 max.)	590	89.8	2.2	92.0	0.7	46.0	4.3	73.3	1.4	45.4	3.0

Exhibit 6.1: Beliefs about mathematics and mathematics learning: percent of statements endorsed, by respondent type within country (contd.)

			Mathematics as a Set of Rules and Procedures		Mathematics as a Process of Enquiry		Learn Mathematics by Following Teacher Direction		Learn Mathematics through Active Involvement		Mathematics as a Fixed Ability	
Country	Respondent Type	*N*	%	*SE*	%	*SE*	%	*SE*	%	*SE*	%	*SE*
Poland[e]	Teacher educators	706	43.4	1.0	81.6	0.9	8.3	0.6	85.3	1.2	22.1	1.0
	Lower primary (Grade 4 max.)	1,778	59.6	1.0	53.6	1.0	19.4	0.6	70.6	0.8	30.3	0.6
	Lower secondary (Grade 10 max.)	156	45.4	2.6	68.6	2.1	12.0	1.5	71.9	2.0	21.4	1.8
	Primary mathematics specialists	298	38.6	2.3	77.2	2.0	7.7	0.6	80.6	2.1	17.3	1.3
	Secondary (Grade 11+)	138	35.5	2.6	77.8	2.9	6.7	1.1	75.8	2.9	19.4	1.6
Russian Federation[f]	Teacher educators	1,198	50.0	1.4	73.1	0.7	8.2	0.5	82.0	0.8	16.8	0.9
	Lower primary (Grade 4 max.)	2,225	54.2	1.6	61.3	1.6	17.1	1.1	72.0	1.6	26.1	1.3
	Secondary (Grade 11+)	2,097	45.3	1.5	63.7	1.5	13.8	1.0	68.4	1.5	24.8	1.0
Singapore	Teacher educators	74	46.1	3.5	79.3	3.0	9.2	1.7	77.5	2.3	15.8	2.4
	Lower secondary (Grade 10 max.)	142	62.8	3.0	73.5	2.9	15.0	1.5	68.7	1.9	20.2	1.4
	Primary (Grade 6 max.)	261	62.5	1.8	76.4	1.7	12.5	1.0	71.2	1.6	16.0	1.1
	Primary mathematics specialists	117	64.1	2.4	83.5	2.4	10.9	1.5	74.4	2.3	14.9	1.6
	Secondary (Grade 11+)	251	59.8	1.8	77.0	1.4	13.6	1.0	64.7	1.8	18.1	1.5
Spain	Teacher educators	523	50.4	1.6	87.8	0.9	8.3	0.7	76.3	1.2	10.0	0.6
	Primary (Grade 6 max.)	1,086	54.2	1.5	73.4	1.4	11.8	0.5	68.6	1.7	13.9	0.5
Switzerland[g]	Teacher educators	214	29.0	2.2	76.7	1.8	3.9	0.5	86.4	1.4	5.6	0.8
	Lower primary (Grade 4 max.)	119	33.8	2.4	60.8	2.2	3.2	0.5	82.5	1.9	4.8	0.6
	Lower secondary (Grade 10 max.)	140	27.3	1.9	72.0	2.0	3.4	0.6	83.1	1.8	7.0	1.1
	Primary (Grade 6 max.)	812	28.0	1.0	63.3	0.9	2.8	0.2	81.2	0.6	6.5	0.4
Thailand	Teacher educators	306	70.7	2.1	84.9	1.5	10.3	0.9	72.5	1.9	34.1	1.5
	Primary mathematics specialists	656	77.2	0.9	83.8	0.9	12.0	0.5	71.4	0.9	36.1	0.8
	Secondary (Grade 11+)	645	77.6	0.7	83.3	0.9	15.3	0.7	71.8	0.9	40.2	1.0
United States[h]	Lower secondary (Grade 10 max.)	126	67.6	5.8	82.3	2.1	10.7	2.5	73.7	1.8	10.0	1.6
	Primary (Grade 6 max.)	1,005	59.2	1.9	77.9	1.3	9.8	0.8	72.8	0.9	9.8	0.8
	Primary mathematics specialists	144	61.1	3.8	83.3	1.7	9.7	1.6	77.3	1.6	9.2	2.3
	Secondary (Grade 11+)	365	52.1	2.0	86.8	1.6	6.1	1.1	73.5	1.8	6.3	0.7

Note: This table should be read in conjunction with the limitations a through h annotated on page 159.

Further cautions are in order. Many countries have programs that prepare their students to teach at both primary and lower-secondary levels. Where this was the case, the samples were divided into random halves, and the future primary teacher questionnaire was administered to one half and the future lower-secondary teacher questionnaire administered to the other half. This method permitted computation of summary statistics for the two populations of interest: those who would qualify, on graduation, to teach in primary schools, and those who would qualify, on graduation, to teach in lower-secondary schools. It is important to note that the sample data yielded unbiased estimates for each of the two TEDS-M populations.

Because of overlap among the program-groups, it was not possible to present national statistics for Norway's future teachers; instead, we broke down and presented Norway's data in non-overlapping groups. At the time of the TEDS-M data collection, Thailand had no programs catering solely for future primary teachers or solely for future lower-secondary teachers. Therefore, in Exhibits 6.2 through 6.6, the data for Thailand are a combination of the data for the two teacher populations.

Exhibit 6.1 contains a considerable amount of detail, and it may not be easy to discern underlying patterns from it. Careful study of this exhibit reveals, however, substantial and systematic differences across countries, but generally much smaller differences among program-groups within countries. The presentation may therefore be simplified by focusing on countries rather than on program-groups, and that is the basis on which we constructed Exhibits 6.2 through 6.6.

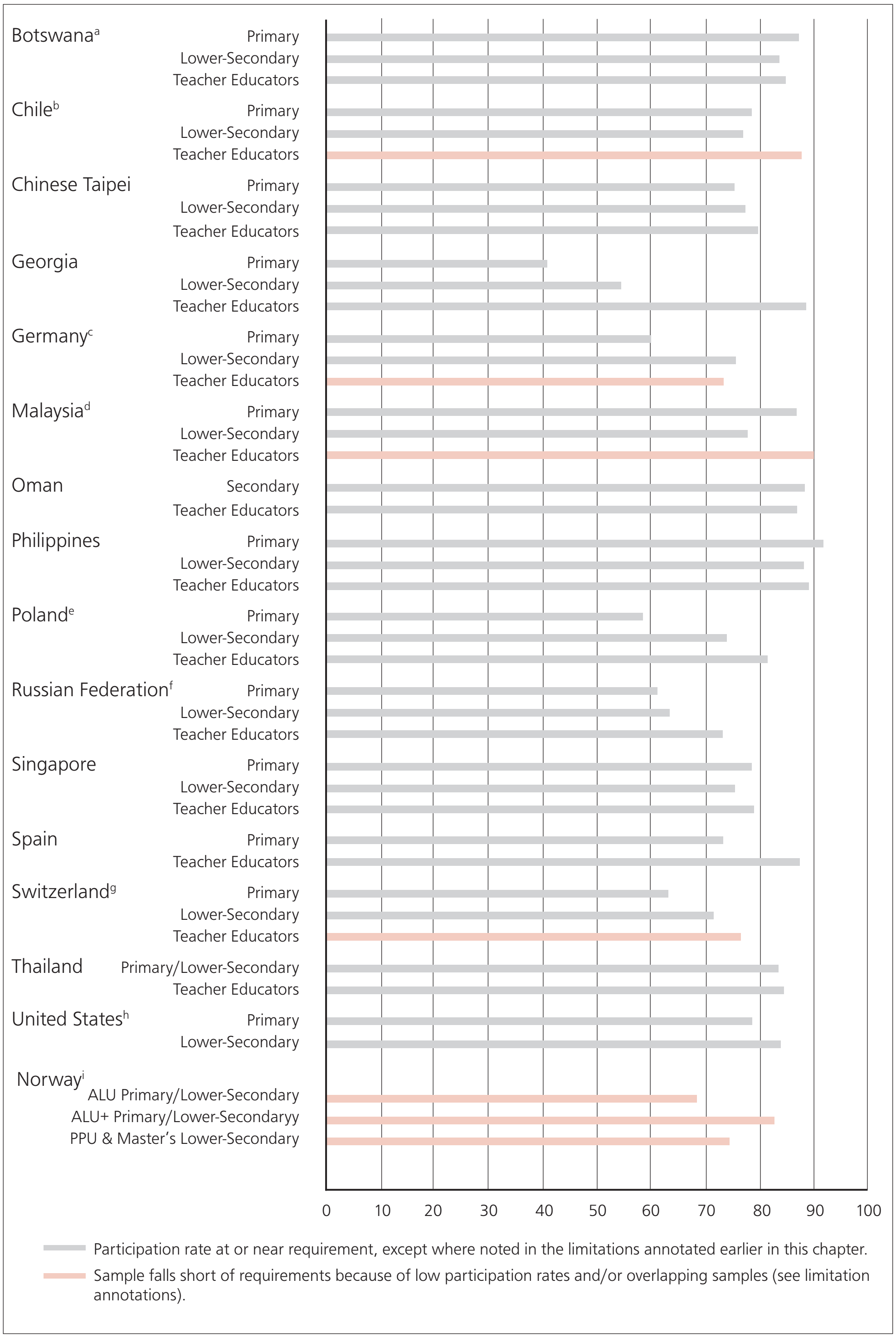
Several clear patterns are evident in Exhibits 6.2 through 6.6. Overall, we can see that the extent to which the various respondent groups endorsed beliefs about the nature and teaching of mathematics varied substantially across countries; with few exceptions, the differences observed among countries far outweighed any differences that could be observed among the three groups of respondents within countries. The one exception to this pattern was Georgia. Georgian teacher educators were more inclined than their future teachers to endorse statements supporting a view of mathematics as a process of enquiry, and simultaneously more inclined to endorse statements supporting a view of mathematics as a set of rules and procedures. They were less inclined than their students to support a view that mathematics is learned by following teacher direction, but more inclined than their students to endorse a view that mathematics is learned through active involvement. The Georgian teacher educators and their future teachers were, however, both inclined to support the view that mathematics is a fixed ability. Their level of support for these statements, moreover, was very high compared to endorsements for this view held by the respondent groups in most countries.

The respondent groups in all countries generally strongly endorsed the view that mathematics is a process of enquiry. However, the level of endorsement in Georgia was considerably weaker among the future teachers than among the teacher educators. This pattern was evident, but to a much lesser degree, in several other countries, namely Chile, Poland, the Russian Federation, and Spain. The view of mathematics learning that would generally be seen as consistent with this view of mathematics—mathematics is learned through active involvement—was also strongly supported in all countries surveyed, but again the future teachers in Georgia were far less likely than the teacher educators to endorse it.

Exhibit 6.2: ***Mathematics is a set of rules and procedures:*** *percentages of future teachers and teacher educators endorsing this statement, by country*

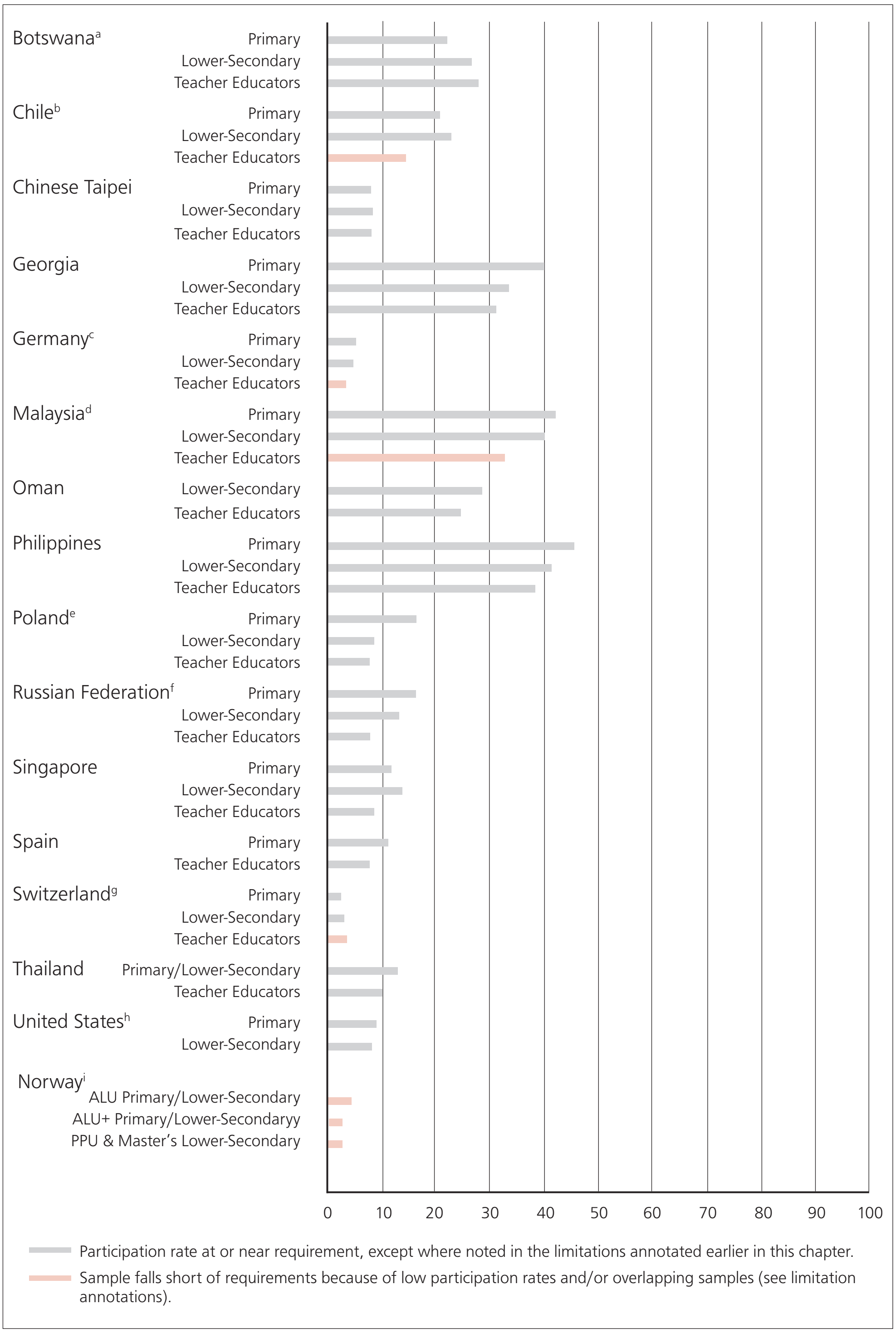
Note: Participation rate at or near requirement, except where noted in the limitations annotated on page 159.

Exhibit 6.3: ***Mathematics is a process of enquiry:*** *percentages of future teachers and teacher educators endorsing this statement, by country*



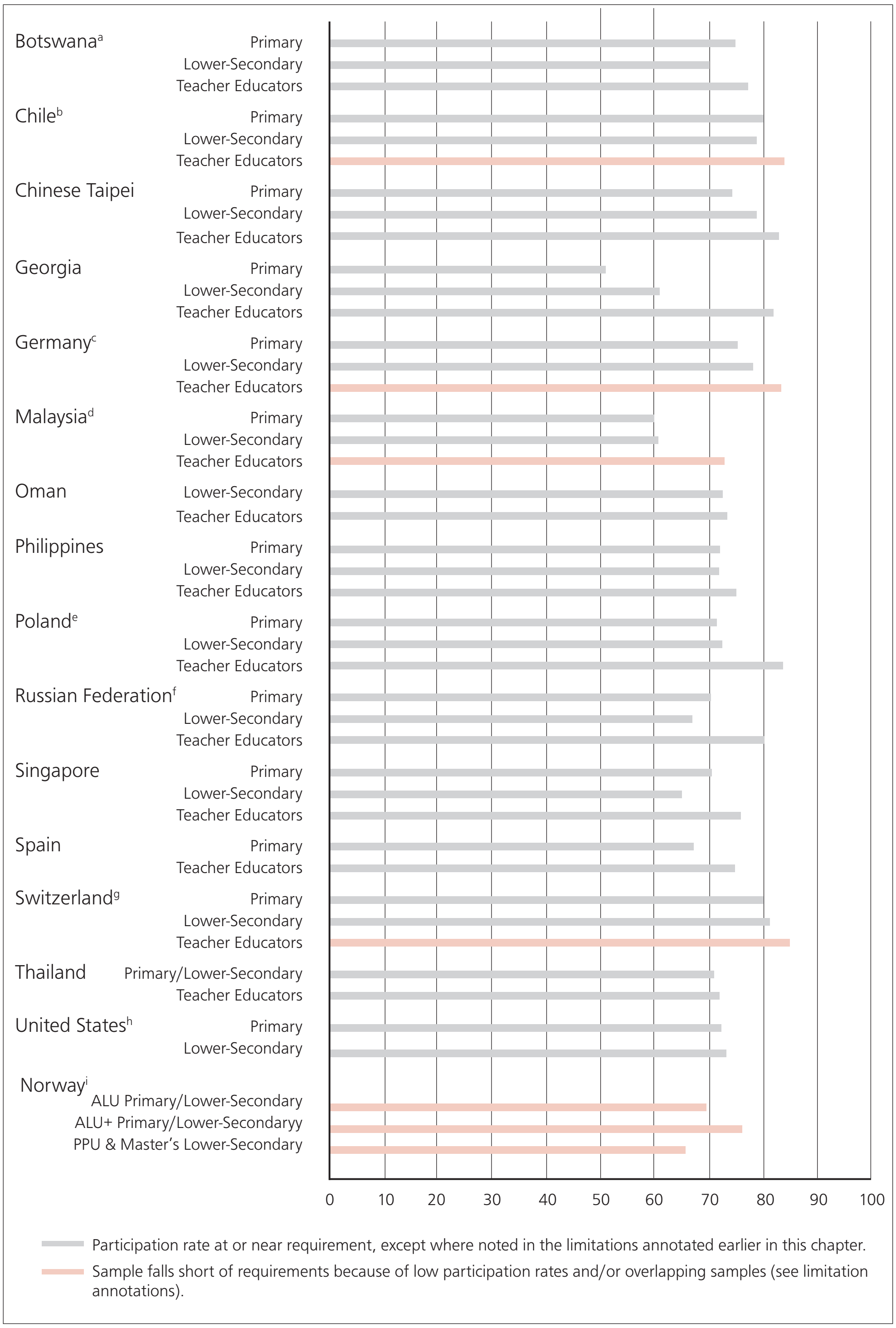
Note: Participation rate at or near requirement, except where noted in the limitations annotated on page 159.

Exhibit 6.4: ***Learn mathematics by following teacher direction:*** *percentages of future teachers and teacher educators endorsing this statement, by country*



Note: Participation rate at or near requirement, except where noted in the limitations annotated on page 159.

Exhibit 6.5: ***Learn mathematics through active involvement:*** *Percentages of future teachers and teacher educators endorsing this statement, by country*



Note: Participation rate at or near requirement, except where noted in the limitations annotated on page 159.

Exhibit 6.6: ***Mathematics is a fixed ability:*** *Percentages of future teachers and teacher educators endorsing this statement, by country*

Note: Participation rate at or near requirement, except where noted in the limitations annotated on page 159.

The view of mathematics as a set of rules and procedures is reasonably compatible with that of mathematics as a process of enquiry, so we could assume that it would be strongly supported in many countries, which it was. The strongest endorsement of mathematics as a set of rules and procedures came from the Botswana, Georgia, Malaysia, Oman, Philippines, and Thailand; the strongest rejections of this view came from Germany, Switzerland, and Norway. The view that mathematics is best learned by following teacher direction was much less strongly supported, but the country differences were large. This view of mathematics learning received its greatest support in the Georgia, Malaysia, and Philippines; it was most strongly rejected in Germany, Norway, and Switzerland.

The view of mathematics as a fixed ability carries with it the implication that mathematics is not for all—that some children cannot and will not succeed in mathematics. This view has serious implications for how children are grouped and how they are taught. Although a minority view in all countries surveyed, it was most strongly supported by teacher educators and future teachers in Botswana, Georgia, Malaysia, the Philippines, and Thailand. The countries that most firmly rejected this notion were Germany, Norway, Switzerland, and the United States. In summary, the beliefs most consistent with those described by Philipp (2007), Thompson (1992), and Thompson et al. (1994) as a conceptual orientation attracted strong endorsement from teacher educators and future teachers in all countries, although the respondent groups in Georgia were those groups least likely to support these beliefs.

The patterns of beliefs most consistent with those described by the above authors as calculational were most widely endorsed by teacher educators and future teachers in Botswana, Georgia, Malaysia, Oman, the Philippines, and Thailand, and most consistently rejected by the corresponding respondent groups in Germany, Norway, and Switzerland. The patterns of response from several countries (Chile, Chinese Taipei, Poland, the Russian Federation, Singapore, and Spain) were generally consistent with the conceptual orientation, but still gave strong endorsement to the belief that mathematics is a set of rules and procedures.

6.6.3 Relationships between Beliefs and Mathematics Knowledge

As noted previously, research evidence, although limited, suggests the following:

1. Positive student outcomes are most likely to be associated with teachers who support the notions that mathematics is a process of enquiry and that learning mathematics requires active involvement; and
2. Less likely to be associated with teachers who support the beliefs that mathematics is a set of rules and procedures, learning mathematics requires following teacher direction, and mathematics is a fixed ability.

While the data collected during TEDS-M did not allow us to test these hypotheses, we were able to examine the relationships between each of these beliefs and the mathematics-related knowledge of the future teachers.

At the country level, the future teachers in all countries generally strongly supported the beliefs that mathematics is a process of enquiry and that learning mathematics requires active involvement. There was therefore little variation by country. There was, however, considerable diversity across the countries in the extent to which future teachers believed that mathematics is a set of rules and procedures, learning mathematics requires following teacher direction, and mathematics is a fixed ability.

The literature that we reviewed also led us to expect that the first two beliefs would be positively related to the two knowledge measures, while the latter three beliefs would be negatively correlated with them. At the country level, the data were largely consistent with this expectation. The countries most strongly endorsing the beliefs consistent with the conceptual orientation were generally those with higher mean scores on the knowledge tests, as reported in Chapter 5. The countries most strongly endorsing the beliefs consistent with the calculational orientation were generally among those with lower mean scores on the knowledge tests.

However, it would be unwise to draw definite conclusions from these results, for two reasons. First, the TEDS-M sample of countries was quite small. Second, the participating countries differ greatly from one another both culturally and historically, and these differences may influence both beliefs and knowledge in unknown ways.

It is also important to note that whatever generalizations might be made, there are exceptions. In Chinese Taipei, for example, the patterns of response were generally consistent with the conceptual orientation, except for mathematics as a set of rules and procedures, for which endorsement was moderately strong. Chinese Taipei is a country where knowledge levels are exceptionally high, but cannot be unambiguously fitted into the two-way categorization that the literature offers us.

Acknowledging that correlations computed within countries might shed some light on the relationships between knowledge and beliefs, free of systematic country differences, we used IRT to scale the five beliefs. We then computed correlations between each of these scales and the measures of mathematics content knowledge (MCK) and mathematics pedagogy content knowledge (MPCK).

Exhibits 6.7 and 6.8 show these correlations for MCK and MPCK, respectively. In these tables, the only correlations reported are those that were significantly different from zero. We applied a one-tailed test because the hypotheses being tested were clearly directional. It is worth noting that non-significant correlations within countries can occur because of a lack of relationship between measures brought about by restricted variance within countries and small sample sizes.

Examination of Exhibits 6.7 and 6.8 reveals that the correlations were generally small. However, of the 153 significant correlations, 151 were in the hypothesized direction. It is fair to conclude, then, that within countries there was a general tendency for future teachers who endorsed the beliefs that mathematics is a process of enquiry and that learning mathematics requires active involvement to have relatively greater knowledge of mathematics content and pedagogy than those who rejected those beliefs. Similarly, there was a general tendency within countries for those future teachers endorsing the beliefs that mathematics is a set of rules and procedures, learning mathematics requires following teacher direction, and mathematics is a fixed ability to have relatively lesser knowledge of mathematics content and pedagogy than those who rejected those beliefs. Again, the relationships were weak, but consistent.

Exhibit 6.7: Correlations of beliefs about mathematics and mathematics learning with mathematics content knowledge, by country[1]

Country[2]	*N* (Minimum)[3]	Rules and Procedures	Process of Enquiry	Teacher Direction	Active Involvement	Fixed Ability
Future Primary Teachers						
Botswana	84					-0.19
Chile	630	-0.13	0.11	-0.17	0.11	-0.09
Chinese Taipei	923		0.15	-0.17	0.11	-0.10
Georgia	459					
Germany	977	-0.19	0.36	-0.14	0.22	-0.11
Malaysia	561		0.15		0.10	
Philippines	586		0.18	-0.25		-0.14
Poland	2,063	-0.32	0.27	-0.39	0.17	-0.24
Russian Federation	2,211		0.13	-0.15	0.11	-0.13
Singapore	377	-0.11		-0.12		
Spain	1,082	-0.20	0.15	-0.16	0.09	-0.11
Switzerland	928	-0.17	0.13		-0.05	-0.08
Thailand	652	-0.12	0.10	-0.38	0.08	-0.26
United States	1,079	-0.26	0.21	-0.24	0.18	-0.15
Future Lower-Secondary Teachers						
Botswana	51				0.34	
Chile	706	-0.09	0.10			
Chinese Taipei	364	-0.21		-0.22	0.13	
Georgia	75	-0.17		-0.32		-0.40
Germany	758		0.14		0.18	
Malaysia	383					
Oman	266		0.21			
Philippines	725			-0.17		-0.14
Poland	291	-0.30	0.12	-0.25		
Russian Federation	2,075	-0.07	0.07	-0.12	0.09	
Singapore	390	-0.18	0.10	-0.13	0.09	
Switzerland	140	-0.18				
Thailand	640		0.13	-0.27	0.06	-0.13
United States	475	-0.33	0.11	-0.26		-0.24

Notes:

1. Only those correlations that were significantly different from zero ($\alpha = 0.05$, one-tailed) are reported here.
2 .Norway is not included because it was not possible to aggregate to the country level, due to sampling issues.
3. The *N* used when calculating correlations varied slightly across measures because of occasional non-response, but usually by a fraction of one percent. The reported *N* is the minimum across measures for each country.
4. The shaded areas identify data that, for reasons explained in the annotations on page 159, cannot be compared with confidence to data from other countries.

Exhibit 6.8: Correlations of beliefs about mathematics and mathematics learning with mathematics pedagogy content knowledge, by country[1]

Country[2]	*N* (Minimum)[3]	Rules and Procedures	Process of Enquiry	Teacher Direction	Active Involvement	Fixed Ability
Future Primary Teachers						
Botswana	84					-0.27
Chile	630		0.15	-0.10	0.10	-0.13
Chinese Taipei	923	-0.09	0.13	-0.20	0.09	-0.10
Georgia	459	-0.07				-0.09
Germany	977	-0.21	0.28	-0.16	0.22	-0.15
Malaysia	561			-0.12		-0.08
Philippines	586			-0.22	0.09	-0.16
Poland	2,063	-0.26	0.22	-0.33	0.17	-0.20
Russian Federation	2,211		0.12	-0.15	0.13	-0.15
Singapore	377					
Spain	1,082	-0.11	0.06	-0.11	0.10	-0.12
Switzerland	928	-0.13	0.12	-0.05		-0.16
Thailand	652	-0.15		-0.28		-0.18
United States[h]	1,079	-0.22	0.13	-0.22	0.17	-0.11
Future Secondary Teachers						
Botswana	51					
Chile	706		0.10		0.11	
Chinese Taipei	364			-0.10		
Georgia	75					
Germany	758				0.18	-0.15
Malaysia	383					
Oman	266		0.13			
Philippines	725					
Poland	291	-0.23	0.18	-0.24		
Russian Federation	2,075		0.08	-0.12	0.11	
Singapore	390	-0.11				
Switzerland	140					0.16
Thailand	640			-0.11		-0.08
United States[h]	475	-0.39	0.09	-0.24		-0.13

Notes:
1. Only those correlations that were significantly different from zero ($\alpha = 0.05$, one-tailed) are reported here.
2. Norway is not included because it was not possible to aggregate to the country level, due to sampling issues.
3. The *N* used when calculating correlations varied slightly across measures because of occasional non-response, but usually by a fraction of one percent. The reported *N* is the minimum across measures for each country.
4. The shaded areas identify data that, for reasons explained in the annotations on page 159, cannot be compared with confidence to data from other countries.

6.7 Conclusion: Policy Considerations

The results presented in this chapter provide no evidence of cause and effect, and we do not claim that encouraging any particular belief will lead to increases in future teachers' knowledge of mathematics content and pedagogy. But we do note the associations that exist between knowledge and beliefs, and consider these worthy of consideration by those who develop the curriculum for teacher preparation within each country. Agencies and authorities with responsibility for the structure, content, and organization of teacher preparation in participating countries may wish to consider if they are satisfied with the pattern of beliefs revealed in this report, or whether it is a pattern that they would seek to change.

Significant change is unlikely to occur unless teacher-preparation programs explicitly address beliefs about mathematics and mathematics learning. Countries differ greatly, however, in the extent to which the content of teacher-preparation programs is subject to central control. Even where a central authority has responsibility for teacher preparation, introducing new content to the curriculum provides no assurance of attitudinal change.

We note that, almost without exception, the pattern of beliefs held by the future teachers in every country matched the pattern of beliefs held by the teacher educators. This finding suggests that change, if it is to occur, will not come easily, and that substantial change in the beliefs held by future teachers is unlikely unless it is preceded by change in the beliefs held by the teacher educators. To simply alter the teacher-preparation curriculum is unlikely to be sufficient. Marked change in the beliefs of graduating teachers, if it is to occur, would probably require a significant investment in professional development for practicing teachers as well as for teacher educators.

References

Deng, Z. (1995). *Estimating the reliability of the teacher questionnaire used in the Teacher Education and Learning to Teach* (TELT) (National Center for Research on Teacher Learning Technical Series 95-1, 39 pp.). Available online at http://ncrtl.msu.edu/HTTP/TSeries/TS%2095-1.pdf

Grigutsch, S., Raatz, U., & Törner, G. (1998). Einstellungen gegenüber Mathematik bei Mathematiklehrern [Mathematics teachers' epistemological beliefs about the nature of mathematics]. *Journal für Mathematik-Didaktik*, *19*, 3–45.

Lester, F. K. (Ed.). (2007). *Second handbook of research on mathematics teaching and learning.* Charlotte, NC: National Council of Teachers of Mathematics & Information Age Publishing.

Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 257–315). Charlotte, NC: National Council of Teachers of Mathematics & Information Age Publishing.

Schmidt, W., Tatto, M. T., Bankov, K., Blömeke, S., Cedillo, T., Cogan, L., … Schwille, J. (2007, December). *The preparation gap: Teacher education for middle school mathematics in six countries* (MT21 report). East Lansing, MI: Michigan State University. Available online at http://usteds.msu.edu/MT21Report.pdf

Staub, F. C., & Stern, E. (2002). The nature of teachers' pedagogical content beliefs matters for students' achievement gains: Quasi-experimental evidence from elementary mathematics. *Journal of Educational Psychology*, *94*(2), 344–355.

Tatto, M. T. (1996). Examining values and beliefs about teaching diverse students: Understanding the challenges for teacher education. *Educational Evaluation and Policy Analysis*, *18*(2), 155–180.

Tatto, M. T. (1998). The influence of teacher education on teachers' beliefs about purposes of education, roles, and practice. *Journal of Teacher Education*, *49*(1), 66–77.

Tatto, M. T. (1999). The socializing influence of normative cohesive teacher education on teachers' beliefs about instructional choice. *Teachers and Teaching*, *5*(1), 111–134.

Tatto, M. T. (2003). *Evaluating the effectiveness of the teacher preparation program at Michigan State University: Analyzing survey and ethnographic evidence.* Presentation to the annual meeting of the American Educational Research Association, Chicago, Illinois, April 21–25.

Tatto, M. T., & Coupland, D. (2003). Teaching and measuring attitudes in teacher education. In J. Raths & A. McAninch (Eds.), *Teacher beliefs and classroom performance—the impact of teacher education: Advances in teacher education* (Vol. 6, pp. 123–181). Greenwich, CT: Information Age Publishing.

Thompson, A. G. (1992). Teachers' beliefs and conception: A synthesis of the research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127–146). New York: Macmillan.

Thompson, A. G., Philipp, R. A., Thompson, P. W., & Boyd, B. A. (1994). Calculational and conceptual orientations in teaching mathematics. In D. B. Aicheleb & A. F. Croxford (Eds.), *Professional development for teachers of mathematics* (pp. 79–92). Reston, VA: National Council of Teachers of Mathematics.

CHAPTER 7:

OPPORTUNITY TO LEARN

7.1 Chapter Overview

IEA studies dating back to the First International Mathematics Study (Husén, 1967) have collected data on students' and teachers' perceptions of students' opportunities to learn. In TEDS-M, we used the construct of opportunity to learn (OTL) to explore what mathematics, mathematics pedagogy, general pedagogy, and related areas future teachers reported as having studied.

TEDS-M uses the concept of opportunity to learn, as do other studies in the IEA family. However, the way OTL is addressed varies across studies. For example, in IEA's Second International Mathematics Study (SIMS), OTL data were collected from both teachers and students. Both sets of respondents were asked if students had had opportunities to learn the content that would allow them to answer the achievement items in the item pool. In the 1995 iteration of IEA's Trends in Mathematics and Science Study (TIMSS), teachers were asked to what extent they had taught a number of topics. In TEDS-M, future teachers were asked whether or not they had *studied* a number of topics. Because of the variation in the approach used to measure OTL, the data gathered from these different studies are not directly comparable.

7.2 Data Used in this Chapter

The data reported in this chapter come from the TEDS-M future teacher questionnaire (FTQ) that was administered to future primary and lower-secondary teachers. The FTQ asked those about to graduate from their preservice teacher education programs whether they had experienced opportunity to learn (before and during their teacher education) content and skills relating to seven broad areas hypothesized to influence knowledge for teaching mathematics:

1. Tertiary-level mathematics;
2. School-level mathematics;
3. Mathematics education pedagogy;
4. General pedagogy;
5. Teaching diverse students;
6. Learning through school-based experiences; and
7. Coherence of their teacher education program.

Responses to items in each of these areas were combined to form seven corresponding OTL indices. For instance, in order to explore opportunities to learn tertiary-level mathematics, the TEDS-M researchers asked the future teachers if they had ever studied each of a number of topics relating to university-level mathematics. These topics pertained to geometry, discrete structures and logic, continuity and functions, and probability and statistics.

All future teachers at the primary and lower-secondary levels were asked the same OTL questions in order to avoid predetermining the range of content covered by teacher education programs across the participating countries. This strategy also allowed the TEDS-M researchers to explore whether those future teachers who had studied higher levels of mathematics performed better on the knowledge tests.

The TEDS-M team developed and piloted the OTL items. They then analyzed the pilot test results in order to determine the topics for each OTL index. They were aided in this task by a panel of mathematicians and mathematics educators. The team then tested the OTL item questions in a field trial and used confirmatory factor analysis to test for construct validity, that is, whether the measures of the TEDS-M constructs for OTL were consistent with the team's understanding of the nature of those constructs. The confirmatory factor analysis of the main study results was consistent with the results of the pilot tests and the field trial. The team used the confirmatory factor analysis results to construct the OTL indices reported in this chapter.[1]

We report the OTL findings relating to the indices developed for the study separately for each index for the future primary and the future lower-secondary teachers. The four TEDS-M indices relating to the academic content of teacher education programs focused, respectively, on tertiary-level mathematics, school-level mathematics, mathematics education pedagogy, and general pedagogy. For each topic on each of these scales, students were asked to indicate if they had ever studied that topic, either in their current program or earlier. For example, with respect to the tertiary-level mathematics OTL scale, future teachers were given a list of 17 mathematics-related topics and asked to indicate, for each one, whether or not they had studied it. In the exhibits related to those indices in this chapter, we report the results in the form of mean proportions of topics studied by country, within program-group.[2]

The FTQ also included OTL items dealing with areas other than academic content. These included questions about the frequency with which some students experienced activities in their respective programs. The items also included questions on the opportunities students had experienced in regard to learning to teach diverse students, and learning through school-based experiences. Other questions asked future teachers to indicate their degree of agreement or disagreement with statements about the coherency of their teacher education programs.

The OTL measures based on these topics were scaled such that information was combined across multiple items on a four-point rating scale (the choices were never, rarely, occasionally, and often). The measurement model used for these scales was the Rasch model, which made it possible to create a measure that reflected more or less opportunity to learn on an interval scale.[3]

We report the results from these questions and scales as scaled scores. The international average for each of these scales was set at 10. A country mean greater than 10 indicates that students from that country had a greater than average opportunity to learn the topics included on a given scale, while a country mean below 10 means that students had a less than average opportunity of doing this.

1 The development of the OTL questionnaires and the confirmatory analyses for each OTL scale are discussed in detail in the TEDS-M technical report (Tatto, 2012).

2 The proportion of topics or areas studied is an average proportion across participants in each program-type within each country. Average proportion is more sensitive to variation across program-types than an average of topics. This usage also helps one compare across areas and domains, because the number of topics varies across the areas. As a result, the average is not comparable across domains whereas the proportion of topics studied is.

3 These composite measures are stronger measures of OTL because they were scaled through a measurement model (Rasch) rather than by a simple summed score or by taking an average of ordinal rating-scale points and thereby producing an ordinal measure with fewer optimal statistical characteristics. The series of exploratory factor analyses in the pilot and field test trials of the TEDS-M survey made clear that these sets of items were homogenous.

As indicated earlier, the OTL findings presented in the exhibits in this chapter are organized by program-group (see Chapters 2 and 3 for descriptions of the program-groups) for each opportunity to learn index. We caution readers to bear in mind certain limitations on the data from a number of countries when interpreting the results presented and discussed in the exhibits. We list the limitations in the following two panels: the first panel relates to the primary teacher data, and the second to the lower-secondary teacher data.

Limitation annotations for the future primary teachers' opportunity to learn data

a. *Poland:* reduced coverage—institutions with consecutive programs only were not covered; the combined participation rate was between 60 and 75%.
b. *Russian Federation:* reduced coverage—secondary pedagogical institutions were excluded.
c. *Switzerland:* reduced coverage—the only institutions covered were those where German is the primary language of use and instruction.
d. *United States:* reduced coverage—public institutions only; the combined participation rate was between 60 and 75%. An exception was made to accept data from two institutions because, in each case, only one additional participant would have brought the response rate to above the 50% threshold. Although the participation rate for the complete sample met the required standard, the data contain records that were completed via a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Of the 1,501 recorded participants, 1,185 received the full questionnaire. Bias may be evident in the data because of the significant number of individuals who were not administered the full questionnaire.
e. *Botswana:* the sample size was small ($n = 86$) but arose from a census of a small population.
f. *Chile:* the combined participation rate was between 60 and 75%.
g. *Norway:* the combined participation rate was between 60 and 75%. An exception was made to accept data from one institution because only one additional participant would have brought the response rate to above the 50% threshold. Program- types ALU and ALU plus mathematics are reported separately because the two populations partly overlap; data from these program-types cannot therefore be aggregated.

Limitation annotations for the future lower-secondary teachers' opportunity to learn data

a. *Botswana:* the sample size was small ($n = 53$) but arose from a census of a small population.

b. *Chile:* the combined participation rate was between 60 and 75%.

c. *Poland:* reduced coverage—institutions with consecutive programs only were not covered. The combined participation rate was between 60 and 75%.

d. *Switzerland:* reduced coverage—the only institutions covered were those where German is the primary language of use and instruction.

e. *Norway:* the combined participation rate was 58%. Of the programs preparing future teachers to teach up to Grade 10 maximum, program-types ALU, ALU plus mathematics, and PPU and Master's are reported separately because the populations partly overlap; data from these program types cannot therefore be aggregated.

f. *United States:* Reduced coverage—public institutions only; combined participation was between 60 and 75%. An exception was made to accept data from one institution because only one additional participant would have brought the response rate to above the 50% threshold. Although the participation rate for the complete sample met the required standards, the data contain records that were completed via a telephone interview. This method was used when circumstances did not allow administration of the full questionnaire. Of the 607 recorded as participants, 502 received the full questionnaire. Bias may be evident in the data because of the significant number of individuals who were not administered the full questionnaire.

g. *Georgia:* combined participation rate was between 60 and 75%. An exception was made to accept data from two institutions because, in each case, only one additional participant would have brought the response rate to above the 50% threshold.

h. *Russian Federation:* an unknown number of those surveyed had previously qualified to become primary teachers.

7.3 Opportunity to Learn Tertiary-Level Mathematics

The OTL tertiary-level mathematics items explored whether or not future teachers had studied topics from four tertiary-level mathematics areas:

1. Geometry;
2. Discrete structures and logic;
3. Continuity and functions; and
4. Probability and statistics.

Because opportunity to learn in these areas might have occurred before or during the future teachers' preservice education, future teachers were asked to check a box indicating whether they had ever studied each of a number of topics in those areas.

The tertiary-level geometry items included items on foundations of geometry or axiomatic geometry, analytic and coordinate geometry, non-Euclidean geometry, and differential geometry. Discrete structures and logic included items about linear algebra, set theory, abstract algebra, number theory, discrete mathematics, and mathematical logic. Continuity and functions included items about beginning calculus, multivariate calculus, advanced calculus or real analysis, and differential equations. Probability and statistics included items on probability and statistics.

Responses to the items in these areas were aggregated into the tertiary-level mathematics index, which thus represents the composite of topics that the future teachers said they had studied. The mean can be interpreted as the mean proportion of topics studied, with values ranging from a 0 to 1, or a low to high opportunity to learn in that area of study. Exhibit A7.1 in Appendix A shows the OTL index for the tertiary-level mathematics domain. As is evident from this exhibit, the index was based on responses to 17 items from across the four mathematics areas.

Exhibit 7.1 below shows the mean proportions of topics in the tertiary-level mathematics index that the future primary and future lower-secondary teachers said they had studied. The mean is thus the mean proportion of the 17 topics in tertiary-level mathematics that the future primary teachers reported having studied (values range from 0 to 1). The exhibit shows that, on average, future primary teachers in Georgia reported having studied slightly more than half (0.52) of the 17 topics listed either during their teacher education program, or earlier.

7.3.1 Future Primary Teachers

The opportunity to learn results for the future primary teachers revealed a high degree of variability across countries and program-groups. The highest proportions of topics studied were found among the countries in Program-Group 4 (mathematics specialists). The countries were Poland, Thailand, and Malaysia, with means of 0.88, 0.85, and 0.71, respectively. High-achieving countries on the mathematics content knowledge test, such as the Russian Federation (lower-primary generalists), Chinese Taipei (primary generalists), and Singapore (primary generalists and specialists), indicated moderate coverage of these areas. Overall, Program-Groups 1, 2, and 3, that is, those programs preparing future teachers to teach the lower-primary grades through to Grade 10, had a low to medium level of exposure to tertiary-level mathematics; means ranged from 0.23 to 0.62.

Among those future teachers who were being prepared as generalists, only those in Germany, Singapore, and the United States appeared to be relying on previous mathematics knowledge acquired as a result of participating in a consecutive program (see Exhibit 2.1 in Chapter 2). While specialists reported having studied a higher proportion of topics, this finding can also be attributed in some countries to participation in a consecutive program. This was the case for some programs in Georgia, Germany, Malaysia, Norway, Oman, Singapore, Thailand, and the United States.

7.3.2 Future Lower-Secondary Teachers

As Exhibit 7.1 makes clear, there was considerable variability in the proportions of topics studied by the future lower-secondary teachers in the Program-Group 5 countries. Only those future teachers from the Philippines, Poland, and Switzerland had mean proportions of topics studied of 0.70 or higher. Less variability and higher topic coverage in this domain were evident among the future secondary teachers in Program-Group 6. Singapore and Norway (PPU and Master's) were exceptions, with mean proportions of 0.63 and 0.65.

Exhibit 7.1: Proportion of topics in tertiary-level mathematics studied by program-group

Program-Group	Country	*N*	Mean	*SE*	*SD*	% Missing
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	478	0.52	0.01	0.20	5.3
	Germany	918	0.23	0.01	0.22	1.1
	Poland [a]	1,797	0.45	0.00	0.18	1.1
	Russian Federation [b]	2,244	0.55	0.01	0.18	0.8
	Switzerland [c]	121	0.54	0.01	0.17	0.0
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	0.50	0.01	0.17	0.0
	Philippines	589	0.62	0.02	0.19	0.3
	Singapore	261	0.38	0.02	0.27	0.8
	Spain	1,092	0.55	0.01	0.20	0.0
	Switzerland	813	0.60	0.01	0.17	0.2
	United States [d]	1,289	0.42	0.01	0.23	1.6
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana [e]	83	0.46	0.02	0.19	3.6
	Chile [f]	649	0.43	0.01	0.18	1.2
	Norway (ALU) [g]	392	0.47	0.01	0.20	0.0
	Norway (ALU+) [g]	159	0.59	0.02	0.18	0.0
Group 4. Primary Mathematics Specialists	Germany	97	0.48	0.03	0.22	0.0
	Malaysia	570	0.71	0.01	0.23	1.0
	Poland [a]	300	0.88	0.01	0.10	0.0
	Singapore	117	0.38	0.03	0.26	0.0
	Thailand	658	0.85	0.00	0.11	0.3
	United States [d]	187	0.48	0.02	0.25	1.1
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana [a]	34	0.59	0.03	0.16	0.0
	Chile [b]	733	0.44	0.01	0.18	1.8
	Germany	405	0.47	0.01	0.23	0.7
	Philippines	731	0.71	0.01	0.16	0.4
	Poland [c]	158	0.84	0.01	0.13	0.0
	Singapore	140	0.40	0.02	0.28	1.3
	Switzerland [d]	141	0.71	0.01	0.14	0.0
	Norway (ALU) [e]	352	0.46	0.01	0.18	1.0
	Norway (ALU+) [e]	150	0.56	0.01	0.17	1.1
	United States [f]	169	0.42	0.02	0.21	0.0
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana	19	0.72	0.02	0.09	0.0
	Chinese Taipei	365	0.90	0.00	0.11	0.0
	Georgia [g]	75	0.80	0.02	0.15	3.1
	Germany	359	0.71	0.01	0.16	0.7
	Malaysia	388	0.78	0.01	0.15	0.2
	Oman	176	0.86	0.01	0.09	34.4
	Poland	140	0.92	0.01	0.10	0.0
	Russian Federation [h]	2,133	0.95	0.00	0.08	0.4
	Singapore	250	0.63	0.01	0.18	0.4
	Thailand	651	0.85	0.00	0.11	0.1

Notes:

1. When reading this table, keep in mind the limitation annotations listed earlier in this chapter. The footnote letters in the table above signal the limitations particular to sets of data. The letters pertaining to Program-Groups 1 to 4 relate to the shaded information on page 177. Those relating to Program-Groups 5 and 6 appear on page 178.
2. The shaded areas identify data that, for reasons explained in these annotations, cannot be compared with confidence to data from other countries.

The future teachers in Program-Group 6 were more likely than teachers being qualified to teach at any other level to report a relatively high level of exposure to tertiary-level mathematics topics. Of these Group 6 future teachers, those in Chinese Taipei, Poland, and the Russian Federation experienced almost universal coverage of these topics (mean proportions of 0.90 or higher).

7.4 Opportunity to Learn School-Level Mathematics

Future teachers responded to several items that explored whether or not they had studied a number of topics in school mathematics as part of their teacher preparation programs. The topics were selected from seven areas:

1. Numbers;
2. Measurement;
3. Geometry;
4. Functions, relations, and equations;
5. Data representation, probability, and statistics;
6. Calculus; and
7. Validation, structuring, and abstracting.

The OTL index for the school-level mathematics domain was based on responses to seven items, as shown in Exhibit A7.2 in Appendix A.

While some knowledge areas may seem more suitable for future primary teachers to study and others more suitable for future lower-secondary teachers to study, every future teacher surveyed was asked to respond to all of the items. Although the school mathematics curriculum in some countries does not include calculus, TEDS-M found that the Asian countries and other countries whose future teachers did well on the TEDS-M tests did offer such areas as part of future primary and lower-secondary teacher education. Similarly, while the secondary curriculum across a large number of countries calls for instruction in basic statistics, the study found, on the basis of the future teachers' responses, a general gap in this area of teacher education.

Exhibit 7.2 shows the mean proportion of topics in the school-level mathematics index that the future teachers said they had studied. The data are presented by country within program-group.

7.4.1 Future Primary Teachers

The results for the future primary teachers showed a high degree of variability across countries and program-groups. For instance, it was apparent that the higher the grade level targeted by a teacher education program, the more likely it would be for its students to have studied considerable proportions of topics. Among the countries in Program-Group 1, only the Russian Federation reported a high level of opportunity to learn the school-level mathematics topics listed in the questionnaire. Here, the mean proportion was above 0.70.

Among the countries in Program-Group 2, the mean proportions of topics covered ranged from 0.49 to 0.75. In Program-Group 3, the mean proportions of topics studied ranged from 0.59 to 0.83. In contrast, the mean proportions of topics studied by the future teachers in Program-Group 4 were greater, with mean proportions ranging from 0.62 to 0.93. Future teachers from Thailand and Poland reported proportions greater than 0.90.

Exhibit 7.2: Proportion of topics in school-level mathematics studied by program-group

Program-Group	Country	*N*	Mean	*SE*	*SD*	% Missing
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	502	0.64	0.01	0.22	0.8
	Germany	926	0.37	0.01	0.31	0.4
	Poland [a]	1,809	0.44	0.01	0.26	0.1
	Russian Federation [b]	2,260	0.74	0.01	0.18	0.2
	Switzerland [c]	121	0.49	0.02	0.26	0.0
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	0.64	0.01	0.24	0.0
	Philippines	591	0.75	0.02	0.16	0.0
	Singapore	263	0.62	0.01	0.21	0.0
	Spain	1,093	0.68	0.01	0.21	0.0
	Switzerland	813	0.49	0.01	0.22	0.3
	United States [d]	1,290	0.69	0.01	0.20	1.6
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana [e]	86	0.72	0.01	0.16	0.0
	Chile [f]	657	0.59	0.01	0.20	0.0
	Norway (ALU) [g]	392	0.75	0.01	0.13	0.0
	Norway (ALU+) [g]	159	0.83	0.01	0.10	0.0
Group 4. Primary Mathematics Specialists	Germany	97	0.62	0.03	0.22	0.0
	Malaysia	571	0.72	0.01	0.27	0.9
	Poland [a]	300	0.93	0.01	0.14	0.0
	Singapore	117	0.62	0.02	0.20	0.0
	Thailand	659	0.92	0.01	0.15	0.2
	United States [d]	187	0.72	0.01	0.17	1.1
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana [a]	34	0.79	0.02	0.16	0.0
	Chile [b]	745	0.59	0.01	0.20	0.1
	Germany	400	0.60	0.01	0.24	1.8
	Philippines	731	0.81	0.01	0.16	0.4
	Poland [c]	158	0.94	0.01	0.11	0.0
	Singapore	141	0.72	0.02	0.19	0.7
	Switzerland [d]	141	0.79	0.02	0.18	0.0
	Norway (ALU) [e]	355	0.75	0.01	0.14	0.2
	Norway (ALU +) [e]	151	0.82	0.01	0.12	0.0
	United States [f]	169	0.71	0.03	0.17	0.0
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana	19	0.77	0.03	0.19	0.0
	Chinese Taipei	365	0.89	0.01	0.18	0.0
	Georgia [g]	77	0.77	0.02	0.18	1.0
	Germany	348	0.71	0.01	0.22	4.0
	Malaysia	388	0.91	0.01	0.12	0.2
	Oman	268	0.87	0.01	0.13	0.0
	Poland	140	0.91	0.02	0.15	0.0
	Russian Federation [h]	2,135	0.92	0.01	0.15	0.3
	Singapore	250	0.81	0.01	0.18	0.4
	Thailand	650	0.92	0.01	0.15	0.3
	Norway (PPU & Master's) [e]	65	0.81	0.02	0.18	0.0
	United States [f]	434	0.80	0.02	0.25	0.9

Notes:

1. When reading this table, keep in mind the limitation annotations listed earlier in this chapter. The footnote letters in the table above signal the limitations particular to sets of data. The letters pertaining to Program-Groups 1 to 4 relate to the shaded information on page 177. Those relating to Program-Group 5 and 6 appear on page 178.
2. The shaded areas identify data that, for reasons explained in these annotations, cannot be compared with confidence to data from other countries.

The contrast between the mean proportion of topics that the future teachers in Poland in Program-Group 1 reported studying (0.44) and the mean proportion studied by Polish future teachers in Program-Group 4 (0.93) may indicate that programs align their level of topic coverage with the grade levels they expect their future teachers to teach.

7.4.2 Future Lower-Secondary Teachers

With few exceptions, future teachers in programs preparing future teachers to teach mathematics in the lower-secondary grades reported mean proportions of 0.70 or more. Future teachers in Poland reported a proportion greater than 0.90. Exceptions were found in Chile and Germany, where mean proportions were 0.59 and 0.60, respectively.

Countries in Program-Group 6, that is, those preparing future teachers for the lower- and upper-secondary grades, including Grade 11 and above, reported relatively high mean proportions of topics studied. Mean proportions greater than 0.80 were reported for Chinese Taipei, Malaysia, Oman, Norway, Poland, the Russian Federation, and Thailand. In Botswana, Georgia, and Germany, the mean proportions were somewhat lower.

7.5 Opportunity to Learn Mathematics Pedagogy

Future teachers were asked to consider a list of topics related to teaching mathematics, and to indicate whether they had studied each one as part of their teacher preparation program. The opportunity to learn mathematics pedagogy index was based on responses to eight items relating to the following areas:

1. Foundations of mathematics;
2. Context of mathematics education;
3. Development of mathematics ability and thinking;
4. Mathematics instruction;
5. Development of teaching plans;
6. Mathematics teaching;
7. Mathematics standards and curriculum; and
8. Affective issues in mathematics (see also Exhibit 7.3).

The eight areas are listed in detail in Exhibit A7.3 in Appendix A. Exhibit 7.3 below shows the mean proportion of topics in the mathematics pedagogy index that the future teachers said they had studied. The means are presented by country within program-group.

7.5.1. Future Primary Teachers

The results displayed in Exhibit 7.3 show considerable variability across countries and program-groups at the primary school level, particularly in Program-Groups 1 and 2, with proportions of topics reported as studied as low as 0.38 in Germany and as high as 0.81 in Switzerland. Notable among these two groups of future primary teachers are the high proportions reported by the future teachers in the Russian Federation and Switzerland, in Program-Group 1, and by the future teachers in the Philippines, Singapore, Switzerland, and the United States, in Program-Group 2. The proportions of reported topic coverage were moderately high among the future teachers in Program-Group 3, ranging from 0.67 to 0.79. In Program-Group 4 (primary mathematics specialists), the future teachers in all but one country reported a relatively high

Exhibit 7.3: Proportion of topics in mathematics pedagogy studied by program-group

Program-Group	Country	*N*	Mean	*SE*	*SD*	% Missing
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	491	0.57	0.01	0.25	2.8
	Germany	928	0.38	0.01	0.31	0.5
	Poland [a]	1,808	0.59	0.01	0.23	0.6
	Russian Federation [b]	2,252	0.78	0.01	0.20	0.6
	Switzerland [c]	121	0.81	0.02	0.17	0.0
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	0.57	0.01	0.23	0.0
	Philippines	592	0.75	0.02	0.24	0.0
	Singapore	263	0.71	0.01	0.20	0.0
	Spain	1,092	0.57	0.02	0.26	0.1
	Switzerland	813	0.76	0.01	0.21	0.3
	United States [d]	1,023	0.75	0.02	0.22	23.1
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana [e]	85	0.79	0.02	0.21	1.0
	Chile [f]	657	0.67	0.01	0.23	0.0
	Norway (ALU) [g]	391	0.67	0.01	0.24	0.4
	Norway (ALU+) [g]	159	0.73	0.02	0.25	0.0
Group 4. Primary Mathematics Specialists	Germany	97	0.46	0.03	0.24	0.0
	Malaysia	568	0.86	0.01	0.19	1.4
	Poland [a]	300	0.70	0.01	0.20	0.0
	Singapore	117	0.68	0.02	0.22	0.0
	Thailand	660	0.80	0.01	0.19	0.0
	United States [d]	147	0.75	0.05	0.22	22.7
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana [a]	34	0.79	0.04	0.20	0.0
	Chile [b]	741	0.67	0.01	0.25	0.7
	Germany	405	0.52	0.02	0.24	1.2
	Philippines	731	0.68	0.02	0.27	0.4
	Poland [c]	158	0.76	0.02	0.17	0.0
	Singapore	141	0.68	0.02	0.18	0.7
	Switzerland [d]	141	0.75	0.01	0.20	0.0
	Norway (ALU) [e]	355	0.67	0.01	0.22	0.2
	Norway (ALU+) [e]	151	0.73	0.02	0.23	0.0
	United States [f]	129	0.78	0.02	0.18	26.0
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana	19	0.87	0.03	0.14	0.0
	Chinese Taipei	365	0.68	0.01	0.20	0.0
	Georgia [g]	76	0.60	0.03	0.27	2.1
	Germany	353	0.54	0.02	0.29	2.6
	Malaysia	387	0.81	0.01	0.27	0.6
	Oman	268	0.73	0.01	0.20	0.0
	Poland	140	0.71	0.02	0.20	0.0
	Russian Federation [h]	2,133	0.84	0.02	0.19	0.4
	Singapore	250	0.72	0.01	0.20	0.4
	Thailand	647	0.79	0.01	0.19	0.8
	Norway (PPU & Master's) [e]	65	0.74	0.03	0.22	0.0
	United States [f]	369	0.72	0.02	0.23	17.3

Notes:

1. When reading this table, keep in mind the limitation annotations listed earlier in this chapter. The footnote letters in the table above signal the limitations particular to sets of data. The letters pertaining to Program-Groups 1 to 4 relate to the shaded information on page 177. Those relating to Program-Groups 5 and 6 appear on page 178.
2. The shaded areas identify data that, for reasons explained in these annotations, cannot be compared with confidence to data from other countries.

proportion of topics studied. The range extended from 0.68 in Singapore to 0.86 in Malaysia. Overall, a number of program-groups, regardless of grade level and degree of specialization, were emphasizing this domain, with mean proportions of 0.70 or more.

7.5.2 Future Lower-Secondary Teachers

Exhibit 7.3 also shows the mean proportions of topics by program-group in the mathematics education OTL pedagogy index that the future lower-secondary teachers said they had studied. The results for these future teachers were much less variable than those for the future primary teachers. Except for a few exceptions, and regardless of program-group, the future secondary teachers reported mean proportions of 0.70 or more with respect to topic coverage in this domain. The higher levels of coverage (e.g., 0.80 and above) were found in Program-Group 6 in Botswana, Malaysia, and the Russian Federation, and in programs in Norway.

7.6 Opportunity to Learn General Pedagogy

Future teachers were asked to consider a list of pedagogy areas in the education pedagogy domain and to indicate whether they had studied each as part of their current teacher education program. The eight items selected for this domain related to:

1. History of education and education systems;
2. Philosophy of education;
3. Sociology of education;
4. Educational psychology;
5. Theories of schooling;
6. Methods of educational research;
7. Assessment and measurement; and
8. Knowledge of teaching.

Exhibit A7.4 (Appendix A) contains the actual wording of the item stems. Exhibit 7.4 below shows the mean proportion of topics in the general pedagogy index that future teachers said they had studied. The results are presented by country within program group.

7.6.1. Future Primary Teachers

Except in a few instances, the results showed a high degree of uniformity and emphasis with regard to this domain across the countries and programs, with future primary teachers in most programs reporting a mean proportion of 0.70 or higher of topics studied. These results are consistent with findings reported by Tatto, Lehman, and Novotná (2010), which showed that much of the instructional time in teacher education is spent in the domain of general pedagogy. Lower proportions of topics covered were found among the mathematics specialists and notably in the high-achieving (mathematics knowledge) countries of Poland (0.63) and Singapore (0.57).

7.6.2. Future Lower-Secondary Teachers

Exhibit 7.4 shows the mean proportion of topics in the education pedagogy index that the future lower-secondary teachers (by program-group) reported as having studied. The future lower-secondary teachers in Program-Group 5 reported a relatively high proportion of topic coverage in the general pedagogy domain, with teachers in 6 out of 10 countries reporting proportions of 0.80 or above.

Exhibit 7.4: Future primary teachers' opportunity to learn: general pedagogy

Program-Group	Country	*N*	Mean	*SE*	*SD*	% Missing
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	389	.72	.01	.23	22.9
	Germany	927	.69	.01	.21	0.8
	Poland [a]	1,791	.89	.01	.15	1.6
	Russian Federation [b]	2,239	.92	.01	.12	1.1
	Switzerland [c]	120	.93	.01	.10	1.0
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	922	.71	.01	.21	0.2
	Philippines	580	.95	.01	.10	1.3
	Singapore	262	.60	.01	.24	0.4
	Spain	1,063	.77	.01	.19	2.4
	Switzerland	806	.92	.00	.12	1.1
	United States [d]	1,014	.84	.01	.19	23.8
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana [e]	75	.78	.02	.22	13.7
	Chile [f]	638	.88	.01	.16	3.1
	Norway (ALU) [g]	390	.81	.01	.17	0.6
	Norway (ALU+) [g]	154	.80	.01	.22	3.5
Group 4. Primary Mathematics Specialists	Germany	95	.66	.03	.21	0.5
	Malaysia	566	.88	.01	.17	1.8
	Poland [a]	296	.63	.02	.27	1.6
	Singapore	117	.57	.02	.25	0.0
	Thailand	648	.91	.00	.14	1.8
	United States [d]	147	.84	.04	.21	22.7
Group 5. Lower Secondary (to Grade 10 Maximum)	Botswana [a]	28	.84	.02	.17	17.6
	Chile [b]	717	.88	.01	.16	4.3
	Germany	397	.61	.02	.23	1.6
	Philippines	719	.93	.01	.13	1.5
	Poland [c]	158	.75	.02	.21	0.0
	Singapore	141	.61	.02	.22	0.7
	Switzerland [d]	139	.84	.01	.16	1.2
	Norway (ALU) [e]	353	.81	.01	.18	0.7
	Norway (ALU+) [e]	148	.79	.02	.20	2.1
	United States [f]	129	.87	.01	.15	25.6
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana	17	.74	.07	.24	10.5
	Chinese Taipei	363	.70	.01	.20	0.6
	Georgia [g]	59	.54	.03	.25	26.3
	Germany	343	.59	.01	.24	5.9
	Malaysia	385	.89	.01	.18	1.2
	Oman	260	.74	.01	.19	3.1
	Poland	137	.58	.03	.27	5.7
	Russian Federation [h]	2,125	.89	.01	.16	0.9
	Singapore	250	.65	.01	.21	0.4
	Thailand	641	.90	.01	.14	1.6
	Norway (PPU & Master's) [e]	60	.74	.04	.24	7.4
	United States [f]	368	.78	.01	.20	17.4

Notes:

1. When reading this table, keep in mind the limitation annotations listed earlier in this chapter. The footnote letters in the table above signal the limitations particular to sets of data. The letters pertaining to Program-Groups 1 to 4 relate to the shaded information on page 177. Those relating to Program-Groups 5 and 6 appear on page 178.
2. The shaded areas identify data that, for reasons explained in these annotations, cannot be compared with confidence to data from other countries.

Again, the higher-achieving countries of Poland and Singapore gave the least emphasis to these topics, with mean proportions of 0.75 and 0.61 respectively. Future lower- and upper-secondary teachers in Program-Group 6—the teachers who are prepared to teach Grade 11 or above—reported moderate to high coverage.

Future teachers in Poland and Singapore, two of the higher achieving countries in TEDS-M, gave slightly less emphasis to this domain (the proportions were 0.58 and 0.65, respectively). However, Chinese Taipei, the Russian Federation, and Thailand, which also featured among the higher-achieving countries, paid somewhat higher attention to this domain. The mean proportions for these countries were 0.70, 0.89, and 0.90, respectively.

7.7 Opportunity to Learn about Teaching Diverse Students

An increasingly important area for future teachers learning to teach is teaching mathematics to diverse students. In some TEDS-M countries, students are systematically grouped in classes; in others, classes are left purposefully diverse. Nevertheless, many teacher educators see opportunity to learn to teach diverse students as a crucial component of teacher education programs. They see ability to teach in this way as an increasingly important skill as classrooms become more integrated and societies become more diverse.

Future teachers were asked whether they had experienced opportunity to learn to do the following:

1. Develop specific strategies for teaching students with behavioral and emotional problems;
2. Develop specific strategies and curriculum for teaching students with learning disabilities;
3. Develop specific strategies and curriculum for teaching gifted students;
4. Develop specific strategies and curriculum for teaching students from diverse cultural backgrounds;
5. Accommodate the needs of students with physical disabilities in the classroom; and
6. Work with children from poor or disadvantaged backgrounds.

Future teachers were asked to indicate, on a four-point scale (often, occasionally, sometimes, never), how frequently they had learned about teaching diverse students. The actual wording of the item stems can be found in Exhibit A7.5 in Appendix A.

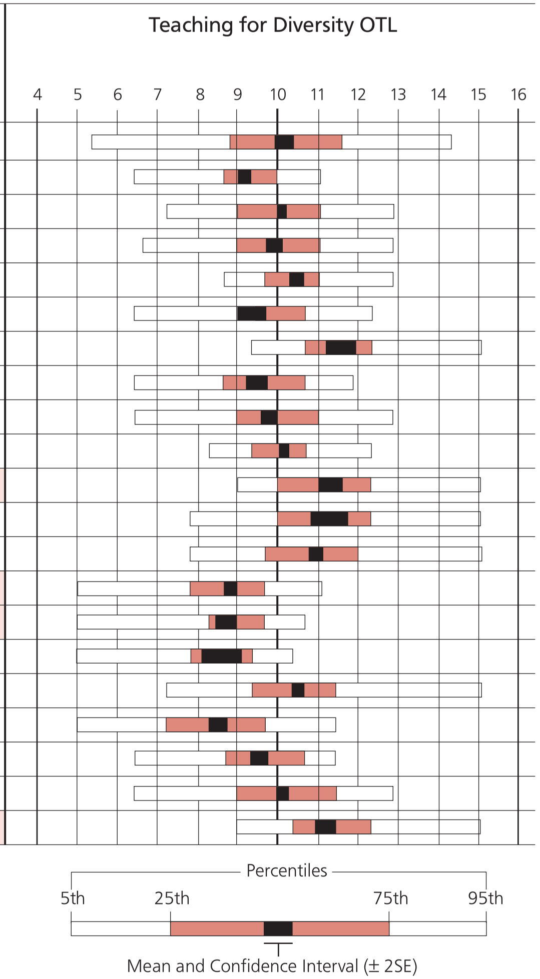
The future teachers' responses are displayed in the form of scale scores by program-group in Exhibit 7.5 for Program-Groups 1 to 4, and in Exhibit 7.6 for Program-Groups 5 and 6. For this analysis, the scale average was set to 10. Scores lower than 10 indicate less opportunity to learn and scores larger than 10 indicate greater opportunity to learn. The interpretation of the index scores is based on Rasch scaling, with a score of 10 representing the midpoint on the rating scale.

7.7.1. Future Primary Teachers

The results for the primary groups showed considerable variability in the future primary teachers' responses. The variability seemed to be less a function of these future teachers being enrolled in a particular program-group and more a function of a cultural norm because almost all of the European countries and some of the Asian countries had means

Exhibit 7.5: Future primary teachers' opportunity to learn: teaching for diversity

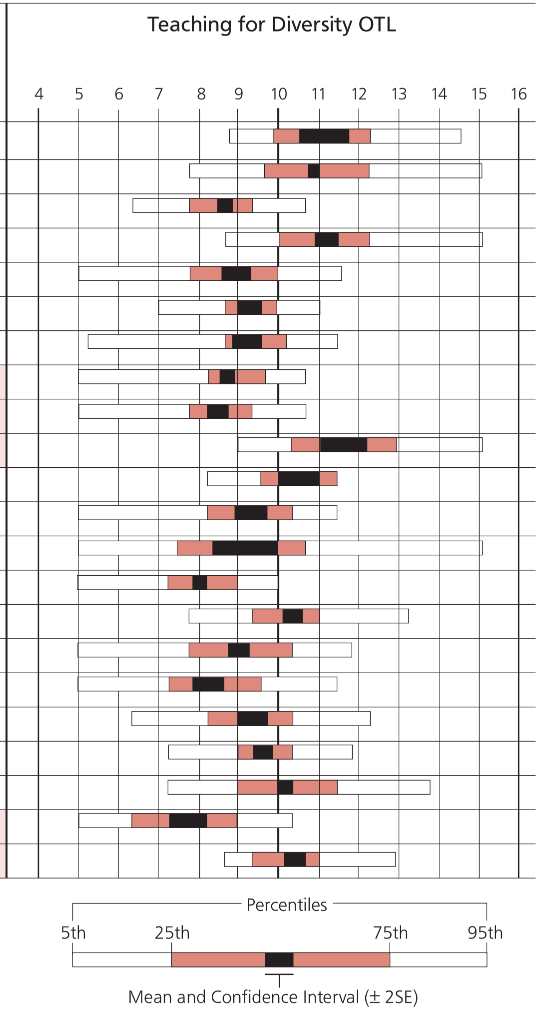
Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia †	506	328	35.0	10.16	(0.11)
	Germany	935	921	1.7	9.14	(0.06)
	Poland [a]	1,812	1,769	2.8	10.07	(0.05)
	Russian Federation [b]	2,266	2,218	2.1	9.91	(0.10)
	Switzerland [c]	121	119	1.7	10.44	(0.08)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	921	0.3	9.54	(0.05)
	Philippines	592	569	4.1	11.55	(0.17)
	Singapore	263	263	0.0	9.48	(0.12)
	Spain	1,093	1,036	4.9	9.80	(0.10)
	Switzerland	815	806	1.3	10.15	(0.05)
	United States †d	1,310	1,015	23.7	11.30	(0.13)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana †e	86	69	20.8	11.29	(0.22)
	Chile [f]	657	617	6.3	10.92	(0.08)
	Norway (ALU) [g]	392	381	5.3	8.79	(0.08)
	Norway (ALU+) [g]	159	151	3.1	8.69	(0.13)
Group 4. Primary Mathematics Specialists	Germany	97	94	0.7	8.57	(0.24)
	Malaysia	576	564	2.1	10.48	(0.07)
	Poland [a]	300	296	2.3	8.47	(0.11)
	Singapore	117	116	0.9	9.48	(0.11)
	Thailand	660	637	3.5	10.11	(0.07)
	United States †d	191	147	22.7	11.18	(0.12)



Notes:
1. This table and chart must be read with awareness of the limitations annotated earlier in this chapter.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit 7.6: Future secondary teachers' opportunity to learn: teaching for diversity

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [†a]	34	26	23.6	11.16	(0.31)
	Chile [b]	746	694	7.5	10.90	(0.06)
	Germany	408	397	1.6	8.64	(0.08)
	Philippines	733	705	2.7	11.22	(0.15)
	Poland [c]	158	153	3.0	8.97	(0.17)
	Singapore	142	140	1.3	9.29	(0.12)
	Switzerland [d]	141	139	1.1	9.21	(0.16)
	Norway (ALU) [e]	356	349	1.9	8.71	(0.08)
	Norway (ALU+) [e]	151	141	6.3	8.49	(0.12)
	United States [†f]	169	128	26.0	11.62	(0.27)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [†a]	19	13	31.6	10.52	(0.25)
	Chinese Taipei	365	362	0.8	9.10	(0.08)
	Georgia [†g]	78	45	42.9	9.21	(0.41)
	Germany	363	344	4.4	8.04	(0.07)
	Malaysia	389	386	0.9	10.34	(0.10)
	Oman	268	248	7.5	8.99	(0.12)
	Poland	140	136	6.8	8.23	(0.19)
	Russian Federation [h]	2141	2108	1.6	9.35	(0.18)
	Singapore	251	250	0.4	9.60	(0.10)
	Thailand	652	634	2.7	10.16	(0.08)
	Norway (PPU & Master's) [e]	65	58	10.9	7.74	(0.19)
	United States [†f]	438	366	18.0	10.42	(0.11)



Notes:
1. This table and chart must be read with awareness of the limitations annotated earlier in this chapter.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

closer to or lower than 10. Exceptions were found among the programs in Botswana, the Philippines, and the United States, where means were greater than 11. Future teachers in Germany, Norway, and Poland reported having never or only occasionally been given opportunity to learn in this area.

7.7.2. Future Lower-Secondary Teachers

The results for the lower-secondary program-groups were even more striking: these teachers reported that they rarely or never had opportunities to learn in this domain. Exceptions were found in Program-Groups 5 and 6 in Botswana and the United States, as well as in the Philippines in Program-Group 5; the means in these countries were higher than 11.

The apparent lack of opportunity to learn about teaching diverse students (e.g., children with learning disabilities, children of the poor, or children of immigrants) was most pronounced in both Program-Groups 5 and 6 in Chinese Taipei, Georgia, Germany, Norway, Oman, Poland, the Russian Federation, Singapore, and Switzerland. The reason for this lack may be because these systems assign school students to classes or schools on the basis of perceived ability, thus effectively "homogenizing" the student body and arguably eliminating the need to factor diversity into the teacher education curriculum.

7.8 Opportunity to Learn to Teach Mathematics through School-Based Experiences

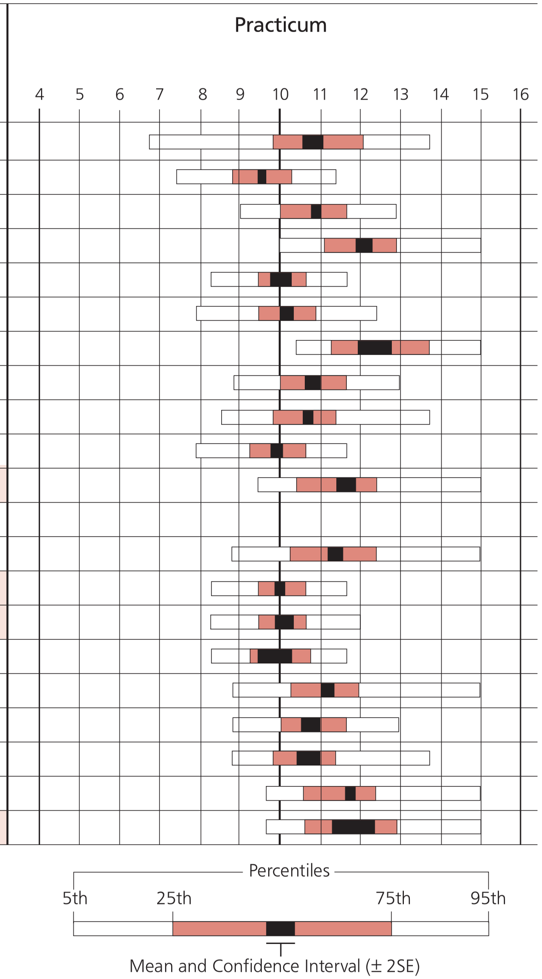
Future teachers were asked to indicate how often during the school experience component of their program they were required to engage in these activities:

1. Observe models of the teaching strategies they were learning in their respective courses;
2. Practice theories for teaching mathematics that they were learning in their courses;
3. Complete assessment tasks that asked them to show how they were applying ideas they were learning in their courses;
4. Receive feedback about how well they had implemented teaching strategies they were learning in their courses;
5. Collect and analyze evidence about student learning as a result of their teaching methods;
6. Test out findings from educational research about difficulties that students experience when learning;
7. Develop strategies that would enable them to reflect on their professional knowledge; and
8. Demonstrate that they could apply the teaching methods they were learning in their courses.

The future teachers were asked to indicate, on a four-point scale (often, occasionally, sometimes, never), how frequently they had been able to see the techniques and skills they had discussed in their teacher education programs enacted in a classroom setting. The wording of the item stems appears in Exhibit A7.6 in Appendix A, and the results are displayed in the form of scale scores by program-groups in Exhibits 7.7 and 7.8 below.

Exhibit 7.7: Future primary teachers' practicum: connecting theory to practice

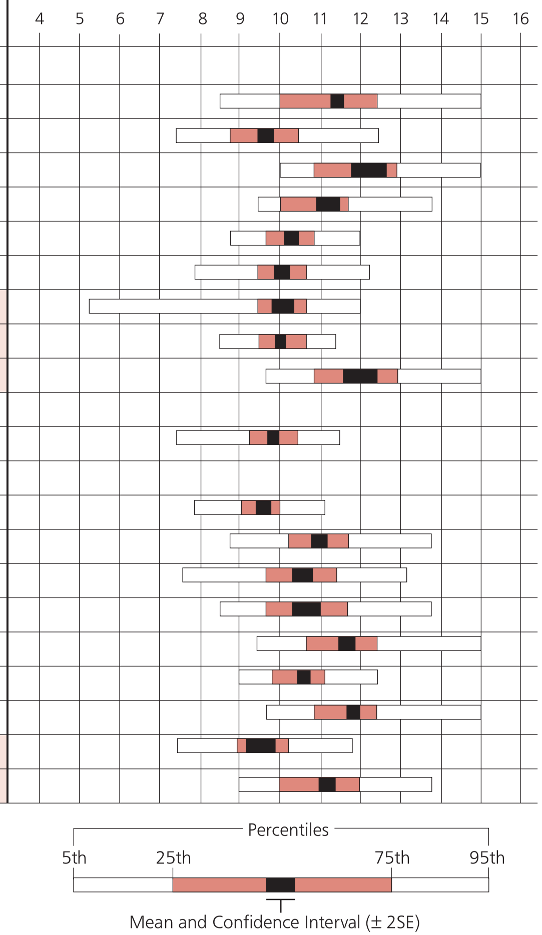
Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean (*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia[†]	506	257	48.7	10.81 (0.12)
	Germany	935	853	8.4	9.53 (0.05)
	Poland [†a]	1,812	1,555	15.0	10.84 (0.04)
	Russian Federation [b]	2,266	2,095	7.4	12.08 (0.09)
	Switzerland [c]	121	107	12.8	10.01 (0.11)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	900	2.4	10.13 (0.08)
	Philippines[†]	592	444	24.4	12.36 (0.21)
	Singapore	263	262	0.4	10.79 (0.10)
	Spain[†]	1,093	912	16.6	10.68 (0.05)
	Switzerland	815	751	8.4	9.89 (0.06)
	United States [†d]	1,310	977	25.6	11.65 (0.11)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[†e]	86	40	55.6	
	Chile [†f]	657	492	25.1	11.38 (0.07)
	Norway (ALU) [†g]	392	323	18.8	9.99 (0.05)
	Norway (ALU+) [†g]	159	120	26.2	10.08 (0.11)
Group 4. Primary Mathematics Specialists	Germany	97	84	14.7	9.84 (0.20)
	Malaysia[†]	576	407	29.3	11.14 (0.08)
	Poland [a]	300	261	12.9	10.73 (0.11)
	Singapore	117	116	0.8	10.69 (0.13)
	Thailand[†]	660	531	19.5	11.74 (0.05)
	United States [†d]	191	140	25.5	11.81 (0.26)



Notes:
1. This table and chart must be read with awareness of the limitations annotated earlier in this chapter.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. Charts or statistics are not presented in instances where more than 50% of the data were missing.

Exhibit 7.8: Future secondary teachers' practicum: connecting theory to practice

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)	Practicum
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [†a]	34	10	70.7			
	Chile [†b]	746	553	26.3	11.42	(0.08)	
	Germany[†]	408	335	17.5	9.62	(0.09)	
	Philippines[†]	733	554	24.5	12.17	(0.21)	
	Poland [c]	158	143	8.0	11.17	(0.15)	
	Singapore	142	139	2.1	10.26	(0.08)	
	Switzerland [d]	141	134	4.0	10.03	(0.08)	
	Norway (ALU) [†e]	356	288	24.3	10.03	(0.05)	
	Norway (ALU+) [†e]	151	113	19.3	10.06	(0.12)	
	United States [†f]	169	125	25.9	11.99	(0.20)	
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [†a]	19	5	73.7			
	Chinese Taipei	365	353	3.3	9.82	(0.07)	
	Georgia [†g]	78	22	72.6			
	Germany[†]	363	268	24.1	9.56	(0.09)	
	Malaysia[†]	389	271	31.2	10.97	(0.10)	
	Oman[†]	268	191	28.9	10.56	(0.12)	
	Poland[†]	140	118	22.1	10.66	(0.18)	
	Russian Federation [h]	2,141	2,017	5.7	11.64	(0.10)	
	Singapore	251	243	3.2	10.58	(0.08)	
	Thailand[†]	652	517	20.3	11.79	(0.06)	
	Norway (PPU & Master's)[†e]	65	41	39.2	9.55	(0.17)	
	United States [†f]	438	349	22.0	11.17	(0.10)	



Notes:
1. This table and chart must be read with awareness of the limitations annotated earlier in this chapter.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. Charts or statistics are not presented in instances where more than 50% of the data were missing.

For this analysis, the scale average was set to 10. Scores lower than 10 indicate less opportunity to learn, and scores larger than 10 indicate more opportunity to learn. The interpretation of the index scores is based on Rasch scaling. Thus, a score of 10 represents the midpoint on the rating scale.

7.8.1 Future Primary Teachers

Exhibit 7.7 shows descriptive statistics relating to future primary teachers' opportunities to connect their teacher-education learning with classroom practice, by program-group. With the exception of programs in Chinese Taipei, Germany, Norway, and Switzerland, where means were below or close to 10, most programs across program-groups seemed to be placing some emphasis on helping future primary teachers make connections between what they were learning in their programs and their future teaching practice. The highest means were found in the Russian Federation in Program-Group 1 (12.1), in the Philippines and the United States in Program-Group 2 (12.4 and 11.6, respectively), in Chile in Program-Group 3 (12.4), and in the United States, Thailand, and Malaysia in Program-Group 4 (11.8, 11.7, and 11.1, respectively).

7.8.2 Future Lower-Secondary Teachers

Exhibit 7.8 shows descriptive statistics for future lower-secondary teachers' opportunities to connect their teacher-education learning with classroom practice, by program-group. Means lower than or close to 10 were seen in Program-Group 5 in Germany, Norway ALU, Norway ALU plus mathematics, Singapore, and Switzerland, as well as in Program-Group 6 in Chinese Taipei, Germany, and Norway.

Most programs across program-groups seemed to be giving some emphasis to helping future lower-secondary teachers find connections between what they were learning in their teacher education programs and their classroom practice in schools. The highest means were found in the Philippines, the United States, and Chile in Program-Group 5 (12.2, 12.0, and 11.4, respectively), and in Thailand, the Russian Federation, and the United States in Program-Group 6 (11.8, 11.6, and 11.2, respectively).

7.9 Opportunity to Learn in a Coherent Program

The future teacher questionnaire also addressed the coherence of teacher-education programs, that is, the extent to which future teachers felt their programs had "come together" for them. The coherence scale included items exploring program consistency, explicitness of standards, and expectations across courses. It also included items concerning the experiences that the teacher education programs offered future teachers.

Future teachers were asked to indicate on a four-point scale (agree, slightly agree, slightly disagree, disagree) whether:

1. Their program seemed to be planned to meet the main needs they had at each stage of their preparation;
2. Later courses in the program built on what was taught in earlier courses;
3. The program was organized in a way that covered what they needed to learn to become an effective teacher;
4. The courses seemed to follow a logical sequence of development in terms of content and topics;

5. Each of their courses was clearly designed to prepare them to meet a common set of explicit standard expectations for beginning teachers; and
6. There were clear links between most of the courses in their teacher education program.

The wording of the item stems can be seen in Exhibit A7.7 in Appendix A. The results are displayed in the form of scale scores by program-groups in Exhibits 7.9 and 7.10 below. For this analysis, the scale average was set to 10. Scores lower than 10 indicate less opportunity to learn, and scores larger than 10 indicate greater opportunity to learn. The interpretation of the index scores is based on Rasch scaling, with a score of 10 representing the midpoint on the rating scale.

7.9.1 Future Primary Teachers

Exhibit 7.9 presents descriptive statistics for future primary teachers' opportunities to learn in a coherent teacher education program, by program-group. In general, future primary teachers rated their program as coherent, organized, and meeting a common set of standards, as indicated by the means, which ranged in these instances from 11.2 to 13.9. The two German programs in Program-Groups 1 and 4 were exceptions; here, the means were lower than 10. Some programs were considered highly coherent: for instance, those in Malaysia, the Philippines, the Russian Federation, Thailand, and the United States catering to the generalists and specialists groups. All means were larger than 13. The overall considerable variation in the national means, however, indicates that coherence varied greatly within program-groups.

7.9.2 Future Lower-Secondary Teachers

The means for the lower-secondary program-groups (see Exhibit 7.10) ranged from 10.2 to 14.0, indicating that the future lower-secondary teachers generally considered their programs to be coherent. The only exceptions were the program-groups in Germany and one program-group in Norway. Programs that the future teachers considered highly coherent were those in Program-Group 5 in the Philippines, and the United States, as well as in Program-Group 6 in Chinese Taipei, Malaysia, Oman, the Russian Federation, Singapore, Thailand, and the United States.

7.10 Conclusion: Patterns Relating to Opportunities to Learn

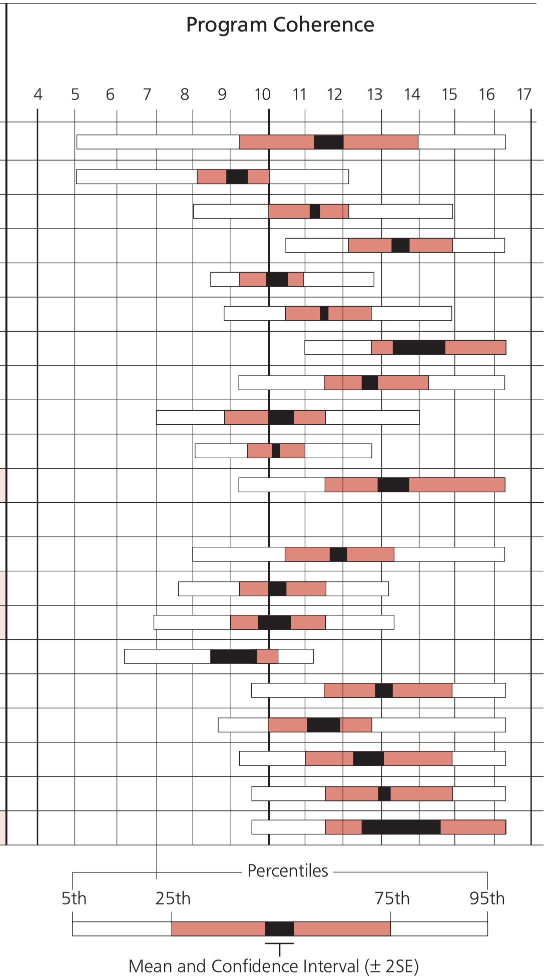
The findings from this chapter are relevant to policymakers, particularly when considered in conjunction with the results of the mathematics content knowledge tests discussed in Chapter 5. This concluding section summarizes a number of general patterns as they relate to the programs featured in TEDS-M. We discuss the perceived relationships between opportunity to learn and the results for the TEDS-M knowledge tests in Chapter 8.

The results of our analysis of the opportunity to learn data in seven major areas of mathematics teacher education showed that:

- Opportunity to learn tertiary mathematics varied greatly across program-groups, often within the same country. This variation seemed to depend on the admission policies for the programs concerned.

Exhibit 7.9: Future primary teachers' program coherence

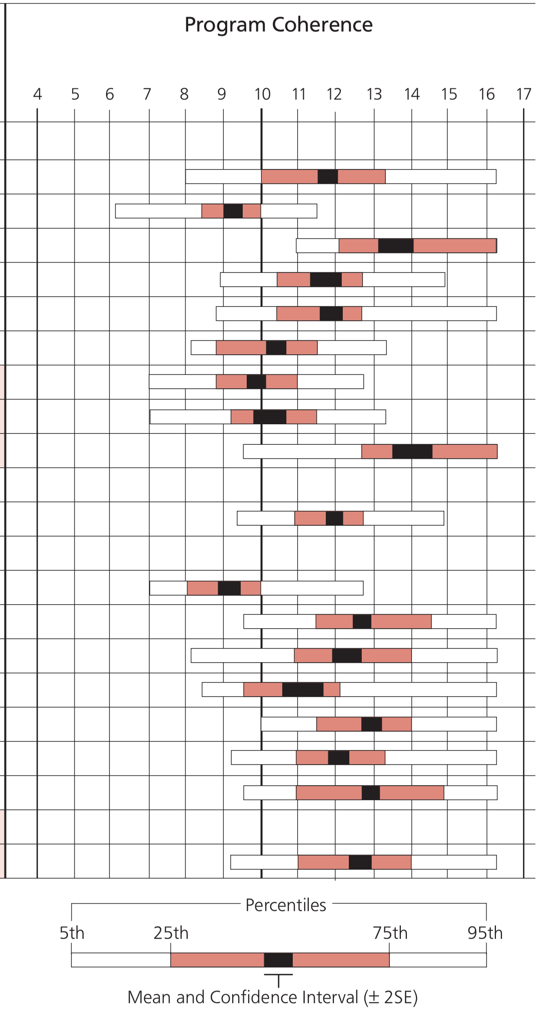
Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia†	506	258	48.9	11.62	(0.19)
	Germany†	935	746	20.3	9.12	(0.12)
	Poland †a	1,812	1,509	19.5	11.20	(0.06)
	Russian Federation b	2,266	2,113	7.7	13.50	(0.12)
	Switzerland †c	121	100	19.3	10.24	(0.14)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	889	3.6	11.47	(0.05)
	Philippines†	592	396	33.0	13.98	(0.33)
	Singapore	263	261	0.8	12.69	(0.10)
	Spain†	1,093	767	30.3	10.30	(0.14)
	Switzerland	815	714	13.3	10.19	(0.05)
	United States†d	1,310	933	28.1	13.32	(0.20)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana†e	86	36	59.9		
	Chile†f	657	393	40.1	11.88	(0.10)
	Norway (ALU)†g	392	267	33.1	10.24	(0.10)
	Norway (ALU+) †g	159	102	37.1	10.14	(0.20)
Group 4. Primary Mathematics Specialists	Germany†	97	74	23.2	8.79	(0.30)
	Malaysia	576	522	9.3	13.10	(0.10)
	Poland a	300	255	13.2	11.47	(0.20)
	Singapore	117	116	0.9	12.66	(0.20)
	Thailand	660	598	9.3	13.06	(0.07)
	United States †f	191	133	28.2	13.54	(0.51)



Notes:
1. This table and chart must be read with awareness of the limitations annotated earlier in this chapter.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. Charts or statistics are not presented in instances where more than 50% of the data were missing.

Exhibit 7.10: Future secondary teachers' program coherence

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana †a	34	6	82.3		
	Chile †b	746	408	46.0	11.79	(0.13)
	Germany†	408	278	31.0	9.25	(0.11)
	Philippines†	733	491	32.4	13.76	(0.31)
	Poland c	158	134	12.1	11.73	(0.20)
	Singapore	142	133	6.2	11.89	(0.15)
	Switzerland d	141	122	11.7	10.42	(0.13)
	Norway (ALU) †e	356	231	36.4	9.89	(0.11)
	Norway (ALU+)†e	151	86	41.5	10.26	(0.21)
	United States †f	169	118	27.2	14.07	(0.25)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana †a	19	2	89.5		
	Chinese Taipei	365	352	3.5	11.96	(0.09)
	Georgia †g	78	18	79.8		
	Germany†	363	236	35.3	9.15	(0.14)
	Malaysia	389	361	8.5	12.70	(0.11)
	Oman†	268	142	46.8	12.28	(0.18)
	Poland†	140	96	33.3	11.14	(0.26)
	Russian Federation h	2,141	1,975	8.0	12.96	(0.12)
	Singapore	251	237	5.6	12.08	(0.12)
	Thailand	652	587	9.8	12.94	(0.11)
	Norway (PPU & Master's)†e	65	26	63.7		
	United States †f	438	323	29.1	12.65	(0.14)



Notes:
1. This table and chart must be read with awareness of the limitations annotated earlier in this chapter.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.
4. Charts or statistics are not presented in instances where more than 50% of the data were missing.

- Opportunity to learn school-level mathematics was highly uniform, referring to the domains of numbers, measurement, and some geometry (typically taught at the primary-school level). However, it was highly variable in the domains of functions, data representation, calculus, and validation.
- Opportunity to learn how to teach diverse students was highly variable, with many countries reporting few or no opportunities to learn in this domain.
- Opportunity to learn general pedagogy was high among all primary programs and most secondary programs.
- Most programs preparing future primary teachers were providing these teachers with opportunities to make connections between what they were learning in their programs and their future teaching practice. These opportunities were not as prevalent, however, among the secondary program-groups.
- The future teachers' level of perceived coherence with respect to their teacher education programs varied across program-groups.

It is evident that those programs focused on preparing teachers to teach higher curricular levels, such as lower-and upper-secondary, provide, on average, opportunities to learn mathematics in more depth than those programs that prepare teachers for the primary level. Thus, on average, the future lower- and upper-secondary teachers participating in TEDS-M were experiencing more opportunity to learn mathematics, at both the tertiary level and the school level, than their primary counterparts. The exception to this pattern was found within the primary mathematics specialist group (Program-Group 4). The future teachers in this group were more likely than the future teachers in any other program-group to report a relatively high level of opportunity to learn tertiary mathematics.

We caution here that these findings need to be considered within the context of national and institutional policies related to teacher education, especially selectivity policies. Nevertheless, the variability evidenced by future teachers regarding their opportunity to learn tertiary-level mathematics is considerable and merits attention.

The findings relating to lower- and upper-school-level mathematics teachers also showed a great deal of variability overall, with more coverage being given in both the primary and secondary programs to areas relating to the basic concepts of numbers, measurement, and geometry and less coverage being given to the areas of functions, probability, and calculus. Among the primary program-groups, only the mathematics specialists in Poland and Thailand reported covering more than 90% of the school-level domains. The future teachers associated with the secondary program-groups generally reported a higher level of opportunity to learn. This variability was mirrored in the opportunities to learn in the mathematics pedagogy domains between the primary and the lower-secondary groups.

References

Husén, T. (Ed.). (1967). *International study of achievement in mathematics: A comparison of twelve countries* (Vol. II). New York: John Wiley & Sons.

Tatto, M. T. (2012). *Teacher Education and Development Study in Mathematics (TEDS-M): Technical report.* Amsterdam, the Netherlands: International Association for Educational Achievement (IEA).

Tatto, M. T., Lerman, S., & Novotná, J. (2010). The organization of the mathematics preparation and development of teachers: A report from the ICMI Study 15. *Journal of Mathematics Teacher Education*, *13*(4), 313–324.

CHAPTER 8:

OVERVIEW OF RESULTS AND CONCLUSIONS

8.1 Chapter Overview: The Study of Mathematics Teacher Education

The goal of teaching mathematics effectively to all children, whatever their background, talent, and motivation, has made teaching more complex and the organization of teacher education more challenging (Tatto, 2007). This is particularly true in secondary mathematics where the pool of suitably qualified applicants tends to be smaller than it is for other school subjects (UNESCO, 2005). As nations across the world move to implement increasingly complex mathematics curricula, policymakers and educators need valid and reliable data about the effectiveness of mathematics teacher education.

The Teacher Education and Development Study in Mathematics (TEDS-M) is the first cross-national study to use nationally representative samples in order to examine the mathematics preparation of future teachers at both the primary and secondary school levels. The research questions that guided the study were:

(1) What are the policies that support primary and secondary teachers' achieved level and depth of mathematics and related teaching knowledge?
(2) What learning opportunities available to prospective primary and secondary mathematics teachers allow them to attain such knowledge?
(3) What are the level and depth of the mathematics and related teaching knowledge attained by prospective primary and secondary teachers at the end of their preservice teacher education?

Seventeen countries participated in TEDS-M. Approximately 22,000 future teachers from 750 programs in about 500 institutions were surveyed and tested. Teaching staff within these programs were also surveyed. In total, close to 5,000 mathematicians, mathematics educators, and general pedagogy educators took part in the study.

Because of the organizational complexity of teacher education in the participating countries, we use this concluding chapter to summarize the diversity that we consider policymakers, educators, and the public need to understand if improvements are to be made to programs educating future teachers of mathematics. We accordingly devote most of the chapter to summarizing the variation within and across the teacher education programs that featured in TEDS-M. Specifically, we consider variation in contexts and policies, in future teachers' mathematics knowledge, mathematics pedagogy content knowledge, and beliefs, and in the opportunities to learn that teacher education programs offer. We end the chapter by discussing the contribution of TEDS-M to the study of mathematics teacher education, and offering suggestions for further work in this area.

8.2 Explaining Country Context and Program Variation

TEDS-M provided new insight into the nature of teacher education across the participating countries. The more we and other members of the TEDS-M research team studied the 17 teacher education systems that participated in TEDS-M, the more aware we became of how varied and complex these systems are. From a research perspective, this organizational complexity proved to be more challenging than that encountered in the elementary and secondary areas of education systems that have been the usual focus of IEA studies. Awareness of this complexity led to an understanding that countyby-country comparisons, as done in most IEA studies, could only be carried out after efforts to ensure that similar types of teacher education programs were being compared. A key task for those of us in the TEDS-M team, therefore, was to develop a terminology and framework suited to analysis of these differences.

8.2.1 Variation across Countries

Countries throughout the world were invited to participate in TEDS-M. The 17 countries that agreed to do so differed in many important geographic, demographic, economic, and educational respects. The TEDS-M sample included very large countries, such as the Russian Federation and the United States of America, as well as small countries, such as Singapore. These countries vary greatly in financial resources, as measured by per capita income, and in the aggregate size of their economies. In addition, a few have high fertility rates that lead to rapidly increasing school enrollments whereas other countries have rates below replacement levels, which could lead to declining school enrollments.

Because of these interactive influences, most of the TEDS-M countries are relatively well off in terms of potential for funding the teacher education that is required, but a few of them face difficult challenges in securing the funding necessary to accommodate growing enrollments. This latter situation is, unfortunately, very widespread outside of the TEDS-M participating countries. TEDS-M, in short, is not representative of the world's countries. Instead, it comprises a relatively advantaged—but still diverse—subsample from which much can be learned.

8.2.2 Variation across Institutions and Programs

The TEDS-M teacher education systems vary in terms of teacher selectivity and status, but generally tend to maintain a satisfactory supply of generalist teachers while experiencing more difficulty in recruiting specialist teachers. The selectivity of teacher education is closely related to the supply of beginning teachers. A shortage of candidates who want to be teachers may result in lowering standards of admission and selectivity during and at the end of the programs (as in the United States of America). In contrast, an oversupply of applicants (as in Chinese Taipei) may lead to tighter admission and selectivity policy and practices.

TEDS-M provided telling evidence of diversity in the number, size, and nature of teacher education institutions across the world. As noted above, TEDS-M surveyed close to 500 teacher education institutions. Within these institutions, 349 programs were preparing future teachers to teach primary students exclusively, 226 programs were preparing future teachers to teach secondary students exclusively, and 176 programs were preparing future teachers to teach primary and secondary students. The number of institutions across participating countries ranged from one institution in Singapore to 78 in Poland.

The nature of these institutions differs widely within and across countries. Some are public, and some are private. Some are universities, and some are colleges outside universities. Some offer programs only in education, and some are comprehensive with regard to the fields of study offered. Some offer university degrees, and some do not.

Teacher education programs are typically categorized according to whether the opportunities to learn that they offer are directed at preparing future teachers for primary schools or for secondary schools. However, this categorization proved to be an over-simplification within the context of TEDS-M. The terms *primary* and *secondary* do not mean the same thing from country to country. There is no universal agreement on when primary grades end and secondary grades begin. Therefore, instead of relying on an assumed primary–secondary dividing line, those of us in the TEDS-M team needed to construct a more refined category based on a fine-grained analysis of the programs.

To ensure that programs with similar purposes and characteristics were being compared across countries, we used two organizational variables—grade span (the range of school grades for which teachers in a program were being prepared to teach) and teacher specialization (whether the program was preparing specialist mathematics teachers or generalist teachers). We therefore classified programs into program-types within countries based on the grade spans for which they prepared teachers and according to whether they prepared *generalist* teachers or *specialist* teachers of mathematics. We then put the same program-types across countries together, a process that led to the formation of six program-groups (four primary and two secondary). During much of our analysis work, this categorization allowed us to break down and report the data along these six groups.

8.2.3 Variation among Teacher Educators

Given the TEDS-M emphasis on the nature and extent of mathematics content and pedagogy offered to future teachers, the study attempted to collect data that would help readers of this report judge whether teacher educators are being appropriately prepared.

Of the close to 5,000 teacher educators surveyed during TEDS-M, the percent with doctoral degrees in mathematics ranged from 7% in the Philippines to over 60% in Chinese Taipei, Georgia, Oman, and Poland. In mathematics pedagogy, the range extended from about 7% in the Philippines to 40% in Georgia. Among these teacher educators, the percent who said they had some experience of teaching primary or secondary school ranged from about 20% in Oman to 90% in Georgia.

TEDS-M asked all participating teacher educators if they considered themselves mathematics specialists. Their responses varied depending on whether they were a mathematician teaching mathematics content to future teachers, a mathematics educator teaching mathematics pedagogy, or a teacher educator teaching general pedagogy. However, a surprising number among those teaching mathematics content or mathematics pedagogy described themselves as non-specialists: nearly 40% of the educators in Chile, Chinese Taipei, Malaysia, the Philippines, and the Russian Federation were in this category. In contrast, close to 70% of the teacher educators in Botswana, Georgia, Germany, Oman, Poland, Singapore, Switzerland, and Thailand reported mathematics as their main specialty.

8.2.4 Variation among Future Teachers

Future teachers being prepared to teach at the primary and secondary school levels in these TEDS-M samples were predominantly female, although there were more males at the higher levels and in particular countries.

Most of the future teachers studied by TEDS-M seemed to come from well-resourced homes, leaving low-income families underrepresented in one of the largest occupations in every country and one that has historically offered an accessible avenue of social mobility. Many of the future teachers reported having access to such possessions as calculators, dictionaries, and DVD players, but not personal computers—now widely considered essential for professional use. The latter was especially the case among teachers living in less affluent countries such as Botswana, Georgia, the Philippines, and Thailand.

The TEDS-M survey found that a relatively small proportion of the sample of future teachers who completed the survey did not speak the official language of their country (which was used in the TEDS-M surveys and tests) at home. This finding suggests that linguistic minorities may be underrepresented in future teacher cohorts in some countries.

Other aspects of the future teachers' self-reports were encouraging. Most future teachers described themselves as above average or near the top of their year in academic achievement by the end of their upper-secondary schooling. Among the reasons the future teachers gave for deciding to become teachers, liking working with young people and wanting to influence the next generation were particularly prevalent. Many believed that despite teaching being a challenging job, they had an aptitude for it.

8.3 Explaining Variation within and across Teacher Education Programs

TEDS-M made apparent the diverse approaches to teacher education across the many programs studied. It could be argued that this diversity represents variations along a policy continuum, with those developing policy seeking to obtain an optimal balance among the plausible opportunities that future teachers need to experience in order to learn the knowledge required to teach mathematics.[1]

8.3.1 Mathematics and Mathematics Pedagogy Content Knowledge

TEDS-M has provided the first solid evidence, based on national samples, of major differences across countries in the (measured) mathematics knowledge outcomes of teacher education. The answer to the TEDS-M research question about the teaching mathematics knowledge that future primary and secondary teachers acquire by the end of their teacher education is clear: for the most part, this knowledge varies considerably among individuals within every country and across countries.

The difference in mean mathematics content knowledge (MCK) scores between the highest- and lowest-achieving country in each primary and secondary program-group was between 100 and 200 score points, or one and two standard deviations. This difference is a substantial one, comparable to the difference between the 50th and the 96th percentile in the whole TEDS-M future teacher sample. Differences in mean achievement across countries in the same program-group on mathematics pedagogical content knowledge (MPCK) were somewhat smaller, ranging from about 100 to 150

1. As an example, Norway implemented a new structure to replace ALU (and ALU+) in 2010, which has taken them a small step toward specialization. They now have:
   - GLU 1–7, which prepares teachers to teach for Grades 1–7. This program-type includes a compulsory mathematics course of 30 credit points.
   - GLU 5–10, which prepares teachers to teach Grades 5–10. This program type includes no compulsory mathematics. However, if future teachers want to qualify to teach mathematics, they must choose at least 60 credit points in mathematics.

Note: GLU is an abbreviation for *grunnskolelærerutdanning* (basic school teacher education).

score points. So, within each program group, and by the end of the teacher preparation programs, future teachers in some countries had substantially greater mathematics content knowledge and mathematics pedagogical content knowledge than others.

On average, future primary teachers being prepared as mathematics specialists had higher MCK and MPCK scores than those being prepared to teach as lower-primary generalists. Also, on average, future teachers being prepared as lower- and upper-secondary teachers had higher MCK and MPCK scores than those intending to be lower-secondary teachers. In the top-scoring countries within each program-group, the majority of future teachers had average scores on mathematics content knowledge and mathematics pedagogy content knowledge at or above the higher MCK and MPCK anchor points.

In countries with more than one program-type per education level, the relative performance on MCK and on MPCK of the future teachers with respect to their peers in other countries was not fixed. For instance, the mean mathematics content knowledge score of future primary teachers in Poland ranked fourth among five countries preparing lower-primary generalist teachers, but first among six countries preparing primary mathematics specialist teachers. This finding suggests that the design of teacher education curricula can have substantial effects on the level of knowledge that future teachers are able to acquire via the opportunities to learn provided for them.

For each participating country and teacher education institution, the TEDS-M results serve as a baseline from which to conduct further investigation. For example, content experts, having looked at the descriptions of the anchor points for MCK and MPCK and the percent of the future teachers graduating from their program or country who reached each anchor point, might elect to study how changes in curriculum can and do lead to improved performance. Policymakers may want to investigate ways to encourage more talented secondary school graduates to select teaching as a career, or they might want to look at how teacher preparation programs of the same duration can lead to higher scores on MCK and MPCK. One conclusion that can be drawn in relation to such considerations is that goals for improving mathematics content knowledge and mathematics pedagogy content knowledge among future teachers should be ambitious yet achievable.

8.3.2 Beliefs

Teachers' actions in the classroom are guided by their beliefs about the nature of teaching and about the subjects that they teach. Acknowledging this, the TEDS-M team gathered data on beliefs from future teachers of mathematics and from the educators preparing them to be teachers. The survey assessed beliefs about the nature of mathematics (e.g., mathematics is a set of rules and procedures, mathematics is a process of enquiry), beliefs about learning mathematics (e.g., mathematics is learned by following teacher direction, through student activity), and beliefs about mathematics achievement (e.g., mathematics is a fixed ability).

The beliefs that mathematics is a set of rules and procedures and that it is best learned by following teacher direction have been characterized in the literature as *calculational* and *direct-transmission* (Phillip, 2007; Staub & Stern, 2002). The beliefs that mathematics is a process of inquiry and that it is best learned by active student involvement are consistent with the beliefs described in the same literature as conceptual and cognitive-constructionist. Several countries (Chile, Chinese Taipei, Poland, the Russian Federation, Singapore, and Spain) showed endorsement for the belief that *mathematics is a set of rules and procedures.*

In general, educators and future teachers in all countries were more inclined to endorse the pattern of beliefs described as conceptual or cognitive-constructionist in orientation. Georgia's endorsement of this pattern was relatively weak, however. Educators and future teachers in Botswana, Georgia, Malaysia, Oman, the Philippines, and Thailand endorsed the pattern of beliefs described as computational or direct-transmission; educators and future teachers in Germany, Norway, and Switzerland for the most part did not.

The view of *mathematics as a fixed ability* carries with it the implication that mathematics is not for all: that some children cannot and will not succeed in mathematics. This view may have implications for how children are grouped and how they are taught. Although this view was a minority one in all countries surveyed, its existence is still a matter of concern because it contravenes the apparent international consensus that all children need to learn mathematics at a higher level than has generally been the case. Future teachers and teacher educators in Botswana, Georgia, Malaysia, the Philippines, and Thailand held to this view, but their counterparts in Germany, Norway, Switzerland, and the United States rejected it.

The TEDS data made apparent substantial cross-country differences in the extent to which such views are held. The program-groups within countries endorsing beliefs consistent with a computational orientation were generally among those with lower mean scores on the knowledge tests. However, it would be unwise to generalize from this finding, for two reasons. First, the sample of countries is quite small. Second, the countries differ greatly from one another both culturally and historically, in ways that may influence both beliefs and knowledge in unknown ways. In some high-scoring countries on the MCK and MPCK tests, future teachers endorsed the beliefs that mathematics is a set of rules and procedures and is a process of enquiry. The TEDS-M findings thus showed endorsement for both of these conceptions within mathematics teacher education. However, what is at issue here is the extent to which teacher education institutions appropriately balance and draw on these conceptions when designing and delivering the content of their programs (Tatto, 1996, 1998, 1999).

8.3.3 Opportunities to Learn in Teacher Education Programs

In TEDS-M, primary school teachers in most countries are prepared as generalists able to teach most, if not all, of the core subjects in the school curriculum. However, some countries also prepare specialist teachers of mathematics to teach below Grade 6. These include Germany, Malaysia, Poland, Singapore, Thailand, and the United States. In lower-secondary schools, specialization is the norm across countries, although in most cases this means teaching not one but two main subjects, such as mathematics and science. A future teacher being prepared to specialize in teaching mathematics is likely to require more mathematics content knowledge than is a future teacher being prepared to teach more than one subject.

One reason for classifying programs in terms of grade span and specialization is that the resulting groups are likely to have different opportunities to learn (OTL), and these opportunities, in turn, are likely to lead to different knowledge outcomes. TEDS-M found that OTL for mathematics, mathematics pedagogy, and general pedagogy depended on the grade level and the curriculum that future teachers were expected to teach. For example, programs for future primary teachers gave more coverage than programs for lower-secondary teachers to the basic concepts of numbers, measurement, and geometry and less coverage to functions, probability and statistics, calculus, and structure. Programs designed to prepare teachers to teach higher grades tended to provide, on average, more opportunities to learn mathematics than those programs that prepared teachers for lower grades.

The findings of this study thus reflect what seems to be a cultural norm in some countries, namely, that teachers who are expected to teach in primary—and especially the lower-primary—grades need little in the way of mathematics content beyond that included in the school curriculum. The pattern among secondary future teachers is generally characterized by more and deeper coverage of mathematics content; however, there was more variability in OTL among those future teachers being prepared for lower-secondary school (known in some countries as "middle school") than among those being prepared to teach Grade 11 and above.

Not surprisingly, the countries with programs providing the most comprehensive opportunities to learn challenging mathematics had higher scores on the TEDS-M tests of knowledge. In TEDS-M, primary-level and secondary-level teachers in high-achieving countries such as Chinese Taipei, Singapore, and the Russian Federation had significantly more opportunities than their primary and secondary counterparts in the other participating countries to learn university- and school-level mathematics.

The TEDS-M findings signal an opportunity to examine how these distinct approaches play out in practice. If relatively little content knowledge is needed for the lower grades, then a lesser emphasis on mathematics preparation and non-specialization can be justified. The key question is whether teachers prepared in this fashion can teach mathematics as effectively as teachers with more extensive and deeper knowledge, such as that demonstrated by specialist teachers. Although TEDS-M has not provided definitive conclusions in this regard (this question necessitates studying beginning teachers and their impact on student learning), what TEDS-M does show is that, within countries, future teachers intending to be mathematics specialists in primary schools had higher knowledge scores on average than their generalist counterparts.

8.3.4 Context and Policy

TEDS-M has shown that teachers' careers and working conditions range from those where teachers are carefully selected, well compensated, and highly regarded to those where there is less selectivity, low salaries, and low status. These careers and conditions are shaped in part by the differences between the two major systems of teacher employment (career-based and position-based) found in the world's public schools, as well as by the various mixed or hybrid models.

Career-based refers to systems where teachers are recruited at a relatively young age to remain in one coherent, clearly organized, public or civil service system throughout their working lives. Teacher education is facilitated by the predictability and stability of careers in these systems. Promotion follows a well-defined path of seniority and other requirements, and teaching assignments follow bureaucratic deployment principles and procedures. Countries able to afford career-based staffing can generally avoid major teacher supply problems and have an advantage in recruiting higher ability applicants.

Conversely, position-based systems take a very different approach to teacher employment. Teachers are not hired into the national civil service or separate national teacher service. Rather, they are hired into specific teaching positions within an unpredictable career-long progression of assignments. As a result, access is more readily open to applicants of diverse ages and atypical career backgrounds. Movement in and out of teaching to raise children or pursue other opportunities is possible. These systems can find it difficult to recruit and retain sufficient numbers of teachers, especially to work in areas such as science and mathematics, which offer entry to attractive opportunities in other occupations. As a result, it is difficult to predict what future teachers in such systems need by way of initial preparation.

In short, this distinction between career- and position-based systems is bound to have a major impact on teacher education. Because appointment in a career-based system is a commitment to lifelong employment, such systems are more justified in investing in initial teacher preparation, knowing that the education system will likely realize the return on this investment throughout the teacher's working life. Often this commitment is made even before the beginner receives any teacher training. In contrast, in position-based systems, such an investment in initial preparation is less justifiable because the system is based on the assumption that individuals move in and out of teaching on a relatively short-term basis, and that some graduates of teacher education may never occupy a teaching position.

One long-term policy evident in all TEDS-M countries is that of requiring teachers to have university degrees. Securing an all-graduate teaching force, that is, a force where all its members have higher education degrees (not just diplomas), has been one of the main goals of teacher education policy in many countries over the years. It has thus affected teacher recruitment and the subsequent experience of these teachers once they are employed. While career-based systems have been the norm in many countries, increasingly the tendency is toward position-based systems. In general, position-based systems, with teachers hired on fixed, limited-term contracts, are less expensive for governments to maintain.

A major part of TEDS-M involved examining the participating countries' policies for assuring the quality of future teachers. We found great variation in these policies, especially with respect to the quality of entrants to teacher education programs, the accreditation of teacher education programs, and methods for assessing the quality of graduates before they can gain entry to the teaching profession.

The TEDS-M data indicated a positive relationship between the strength of quality assurance arrangements and country mean scores in the TEDS-M tests of mathematics content knowledge and mathematics pedagogy knowledge. Countries with strong quality assurance arrangements, such as Chinese Taipei and Singapore, scored highest on these measures. Countries with weaker arrangements, such as Georgia and Chile, tended to score lower on the two measures of future teacher knowledge.

These findings have implications for policymakers concerned with promoting teacher quality. Quality assurance policies and arrangements can make an important difference to teacher education. These policies can be designed to cover the full spectrum, from polices designed to make teaching an attractive career through to policies for assuring that entrants to the profession have attained high standards of performance. The TEDS-M findings point to the importance of ensuring that policies designed to promote teacher quality are coordinated and mutually supportive.

As evident from the TEDS-M data, countries such as Chinese Taipei and Singapore that do well on international tests of student achievement, such as TIMSS, not only ensure the quality of entrants to teacher education but also have strong systems for reviewing, assessing, and accrediting teacher education providers. They also have strong mechanisms for ensuring that graduates meet high standards of performance before gaining certification and full entry to the profession.

Reform in this and other respects seems to be the order of the day among the TEDS-M participating teacher education systems. All were implementing reforms in teacher education in order to enhance the efficacy of their education systems overall. They were also, within the context of TEDS-M, striving to increase the mathematics achievement levels of their students. In the European countries that participated in TEDS-M, changes to entire university systems are underway as a result of the Bologna Accord for the creation of a European Higher Education Area. In other countries, such as Malaysia, changes in teacher education toward more advanced levels of education for teachers have been precipitated by concerns about the limitations and weaknesses of current mathematics, science, and technology education. Although reform is ubiquitous in the TEDS-M countries, it is important to keep in mind that, as in any cross-sectional study, TEDS-M provides only a snapshot of mathematics teacher preparation, singular to the year 2008/2009, when the data were collected.

8.4 Contribution of TEDS-M to the Study of Mathematics Teacher Education

TEDS-M was not only the first cross-national research on teacher education, but also the first cross-national study of higher education. Moreover, the surveys were completed with high response rates and coverage of the target populations, in most cases meeting the very high IEA standards for sampling and response rates. In the limited instances where the IEA standards were not met, the response rates still compared favorably with general experience in higher education surveys, and especially in those cases where the targeted participants were all volunteers.

TEDS-M thus lays the foundation for future rigorous cross-national research in teacher education, having made available a common terminology, sampling methods tailored to teacher education, and instruments and analyses that can be adapted and improved for use in subsequent teacher education studies, whether in mathematics or other curriculum areas. TEDS-M has also served to develop strong capacity within the countries that participated in this study. Finally, we anticipate that the TEDS-M database will contribute to this new line of research by permitting researchers throughout the world to conduct secondary analysis.

References

Philipp, R. A. (2007). Mathematics teachers' beliefs and affect. In F. K. Lester (Ed.), *Second handbook of research on mathematics teaching and learning* (pp. 257–315). Charlotte, NC: National Council of Teachers of Mathematics & Information Age Publishing.

Staub, F. C., & Stern, E. (2002). The nature of teachers' pedagogical content beliefs matters for students' achievement gains: Quasi-experimental evidence from elementary mathematics. J*ournal of Educational Psychology*, *94*(2), 344–355.

Tatto, M. T. (1996). Examining values and beliefs about teaching diverse students: Understanding the challenges for teacher education. *Educational Evaluation and Policy Analysis*, *18*(2), 155–180.

Tatto, M. T. (1998). The influence of teacher education on teachers' beliefs about purposes of education, roles, and practice. *Journal of Teacher Education*, *49*(1), 66–77.

Tatto, M. T. (1999). The socializing influence of normative cohesive teacher education on teachers' beliefs about instructional choice. *Teachers and Teaching*, *5*(1), 111–134.

Tatto, M. T. (2007). *Reforming teaching globally* (Oxford Studies in Comparative Studies in Education). Oxford, UK: Symposium Books. Available online at http://www.symposium-books.co.uk/books/bookdetails.asp?bid=11

UNESCO. (2005). *EFA global monitoring report: The quality imperative*. Paris, France: Author.

APPENDICES

APPENDIX A: Supplementary Exhibits Relating to Chapters 3, 4, 6, and 7

A1: CHAPTER 3 EXHIBITS

Exhibit A3.1: Sources of national demographic and human development statistics

Country	Population (millions)	Area (,1000s of sq. km)	Population Density (People per sq km)	Urban Population (% of total)	Life Expectancy at Birth (Years)	Rank in total GDP	GNI per Capita (Purchasing Power Parity)	Levels of Wealth
Botswana	1.9 [1]	582 [2]	3 [3]	59 [4]	54 [5]	113 [6]	13,250 [7]	Middle [8]
Canada	33.3	9,985	3	80	81	10	38,490	High
Chile	16.8	756	22	88	79	45	13,430	Middle
Chinese Taipei	22.9 [9]	36 [10]	637 [11]	80 [12]	78	20 [13]	32,700 [14]	(High)
Georgia	4.3	70	62	53	72	117	4,860	Low
Germany	82.3	357	230	74	80	4	37,510	High
Malaysia	27.0	331	82	70	74	40	13,900	Middle
Norway	4.8	324	12	77	81	23	60,510	Very high
Oman	2.8	310	9	72	76	74	24,530	Middle
Philippines	90.3	300	301	64	72	47	3,940	Low
Poland	38.1	313	122	61	76	21	17,640	Middle
Russian Federation	141.4	17,098	8	73	68	12	19,770	Middle
Singapore	4.6	1	6,545	100	81	43	52,000	Very high
Spain	44.5	506	88	77	81	9	32,060	High
Switzerland	7.5	41	183	73	82	19	42,220	Very high
Thailand	67.4	513	131	33	69	32	7,830	Low
United States	311.7	9,629	32	81	78	1	47,100	Very high

Notes:

1. Based on United Nations data, "Country Profile" (2008), *World Statistics Pocketbook*, United Nations Statistics Division: http://data.un.org/
   Note in particular: numbers are rounded to the nearest tenth (e.g., 44,486,000 = 44.5); numeric citations refer to entire column, with the exception of Chinese Taipei
2. Based on United Nations data, "Country Profile" (2008), *World Statistics Pocketbook*, United Nations Statistics Division: http://data.un.org/
   Note in particular: numbers are rounded to the nearest tenth (e.g., 505,992,000 = 506)
3. Based on United Nations data, "Country Profile" (2008), *World Statistics Pocketbook*, United Nations Statistics Division: http://data.un.org/
   Note in particular: numbers are rounded to the nearest whole number (e.g., 3.3 = 3)
4. Based on United Nations data, (2007), World Statistics Pocketbook, United Nations Statistics Division: http://data.un.org/
   Note in particular: numbers are rounded to the nearest whole number (e.g., 58.9 = 59)
5. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/
6. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/
   Note in particular: numbers are calculated in international dollars
7. Range: low ($3,000–8,000), medium ($13,000–$25,000), high ($32,000–$39,000), very high ($42,000–$61,000)
8. Based on NationMaster data (2008) derived from World Bank Development Indicators Database and the *CIA World Factbook*: http://www.nationmaster.com/time.php?stat=peo_pop&country=tw
9. Based on *CIA World Factbook*: https://www.cia.gov/library/publications/the-world-factbook/geos/tw.html
10. Based on Ministry of Interior, Department of Statistics, Chinese Taipei (2007): http://www.moi.gov.tw/stat/english/interior.asp
11. Based on Directorate-General of Budget, Accounting, and Statistics, Chinese Taipei (2008): http://www.dgbas.gov.tw/ct.asp?xItem=15408&CtNode=4594&mp=1
12. Based on *CIA World Factbook* (2009): https://www.cia.gov/library/publications/the-world-factbook/geos/tw.html
13. Based on *CIA World Factbook* (2009), US dollars: https://www.cia.gov/library/publications/the-world-factbook/geos/tw.html
14. Based on *CIA World Factbook* (2009), US dollars: https://www.cia.gov/library/publications/the-world-factbook/geos/tw.html

Exhibit A3.2: Sources of national youth and education statistics

Country	Total Fertility Rate[1]	Population Age Composition Ages 0–14 (%)	Public Expenditure on Education	Net Enrollment Ratio in Education		Primary Student–Teacher Ratio
				Secondary	*Primary*	
Botswana	3 [2]	34 [3]	8.1 [4]	90 [5]	64 [6]	25 [7]
Canada	2	17	4.9 [8]	100 [9]	94 [10]	17 [11]
Chile	2	23	3.4 [12]	95 [13]	85 [14]	25 [15]
Chinese Taipei	1 [16]	17 [17]	4.2 [18]	97 [19]	95 [20]	29 [21]
Georgia	2	17	2.7 [22]	99 [23]	81 [24]	9 [25]
Germany	1	14	4.4 [26]	100 [27]	89 [28]	13 [29]
Malaysia	3	30	4.5 [30]	96 [31]	68 [32]	15 [33]
Norway	2	19	6.7 [34]	99 [35]	96 [36]	11 [37]
Oman	3	32	4.0 [38]	72 [39]	78 [40]	12 [41]
Philippines	3	34	2.6 [42]	92 [43]	61 [44]	34 [45]
Poland	1	15	4.9 [46]	96 [47]	94 [48]	11 [49]
Russian Federation	1	15	3.9 [50]	91 [51]	–	17 [52]
Singapore	1	17	2.8 [53]	–	–	19 [54]
Spain	1	15	4.4 [55]	100 [56]	95 [57]	12 [58]
Switzerland	1	16	5.3 [59]	99 [60]	85 [61]	13 [62]
Thailand	2	22	4.9 [63]	89 [64]	72 [65]	16 [66]
United States	2	20	5.5 [67]	93 [68]	88 [69]	14 [70]

Notes:

1. Births per woman
2. Based on "World Development Indicators"(2008), World Bank: http://data.worldbank.org/indicator/SP.DYN.TFRT.IN
   Note, in particular: nationmaster data (2008) includes decimals; numeric citations refer to entire column or to a specific country statistic. Chinese Taipei's statistics came from separate sources
3. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SP.POP.0014.TO.ZS
   Note in particular: data are presented in whole numbers
4. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.XPD.TOTL.GD.ZS
5. Based on United Nations data (2006), "total net enrollment ratio in primary education, both sexes": http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
   Note in particular: these United Nations numbers are rounded to nearest whole number
6. Based on "World Development Indicators" (2005), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
7. Based on "World Development Indicators" (2006), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
8. Based on 2007 data
9. Based on United Nations data (2000), "total net enrollment ratio in primary education, both sexes": http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
10. Based on (1999) data: http://www.nationmaster.com/graph/edu_sch_enr_sec_net-education-school-enrollment-secondary-net
11. Based on 2001 data: http://www.nationmaster.com/graph/edu_pup_rat_pri-education-pupil-teacher-ratio-primary
12. Based on 2007 data
13. Based on United Nations data (2007), "total net enrollment ratio in primary education, both sexes": http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
14. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
15. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
16. Based on Ministry of Interior, Department of Statistics, Chinese Taipei (2008): http://www.moi.gov.tw/stat/english/interior.asp
17. Based on Ministry of Interior, Department of Statistics, Chinese Taipei (2008): http://www.stat.gov.tw/ct.asp?xItem=29593&ctNode=538
18. Based on Ministry of Education, Chinese Taipei (2006): http://english.moe.gov.tw/ct.asp?xItem=8395&ctNode=815&mp=11
19. Based on Ministry of Education, Chinese Taipei (2006): http://english.moe.gov.tw/ct.asp?xItem=8395&ctNode=815&mp=11

20. Based on Ministry of Education, Chinese Taipei (2006): http://english.moe.gov.tw/ct.asp?xItem=8395&ctNode=815&mp=11
21. Based on Ministry of Education, Chinese Taipei (2006): http://english.moe.gov.tw/ct.asp?xItem=8395&ctNode=815&mp=11
22. Based on 2007 data
23. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
24. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
25. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
26. Based on 2006 data
27. Based on United Nations data (2007), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
28. Based on "World Development Indicators" (1996), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR?page=2
29. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
30. Based on 2007 data
31. Based on United Nations data (2007), "total net enrollment ratio in primary education, both sexes": http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
32. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
33. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
34. Based on 2007 data
35. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
36. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
37. Based on "World Development Indicators" (2004), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS?page=1
38. Based on 2006 data
39. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
40. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
41. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
42. Based on 2007 data
43. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
44. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
45. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
46. Based on 2007 data
47. Based on United Nations data (2007), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
48. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
49. Based on "World Development Indicators" (2007), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
50. Based on 2006 data
51. Based on 2004 data: http://www.nationmaster.com/time.php?stat=edu_sch_enr_pri_net-education-school-enrollment-primary-net&country=rs-russia
52. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
53. Based on 2008 data
54. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
55. Based on 2007 data
56. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
57. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR

58. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
59. Based on 2007 data
60. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
61. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
62. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
63. Based on 2008 data
64. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
65. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
66. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries
67. Based on 2007 data
68. Based on United Nations data (2008), "total net enrollment ratio in primary education, both sexes:" http://data.un.org/Data.aspx?q=education+enrolment&d=MDG&f=seriesRowID:589
69. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.SEC.NENR
70. Based on "World Development Indicators" (2008), World Bank: http://data.worldbank.org/indicator/SE.PRM.ENRL.TC.ZS/countries

A2: CHAPTER 4 EXHIBITS

Exhibit A4.1: Mean number of teaching contact hours in liberal arts, academic mathematics, and mathematics content related to the school mathematics curriculum that future primary teachers experience during their programs (estimated means in hours)

Program-Group	Country	Mean Number of Teaching Contact Hours for Liberal Arts Courses			Mean Number of Teaching Contact Hours for Academic Mathematics			Mean Number of Teaching Contact Hours for Mathematics Content Related to the School Mathematics Curriculum		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	10	991	(79.2)	10	280	(61.3)	10	152	(25.5)
	Poland[f]	57	396	(33.5)	54	6	(2.2)	65	31	(4.7)
	Russian Federation[g]	43	1,574	(128.7)	33	454	(86.5)	36	366	(104.1)
	Switzerland[i]	5	493	(192.0)	5	34	(24.6)	5	49	(28.9)
Primary (to Grade 6 Maximum)	Chinese Taipei[a]	6	228	(113.8)	6	17	(7.4)	5	16	(6.7)
	Philippines[e]	32	54	(5.3)	31	50	(4.3)	20	54	(5.5)
	Singapore	4	108	(50.9)	4	216	(101.8)	4	42	(13.0)
	Spain[h]	36	548	(114.9)	31	30	(8.4)	34	63	(14.2)
	Switzerland[i]	10	415	(85.4)	7	85	(24.0)	10	82	(13.1)
	United States[j]	40	492	(59.5)	41	129	(23.2)	43	78	(12.8)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana				1	164	(0.0)	1	84	(0.0)
	Chile[†]	27	1,258	(261.7)	7	211	(48.7)	25	188	(22.9)
	Norway (ALU)[†c]	7	446	(55.7)	2	269	(43.1)	14	356	(42.3)
	Norway (ALU+)[†c]	8	471	(47.2)	3	248	(74.7)	15	360	(42.2)
Primary Mathematics Specialists	Malaysia[b]	7	197	(60.1)	6	186	(96.2)	10	119	(54.0)
	Poland[†f]	34	168	(15.1)	34	950	(52.3)	29	48	(12.3)
	Singapore	2	0	(0.0)	2	0	(0.0)	2	78	(21.2)
	Thailand[†]	34	303	(47.7)	20	343	(49.1)	25	117	(23.9)
	United States[†j]	11	272	(130.9)	13	125	(74.2)	9	61	(31.4)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.2: Mean number of teaching contact hours in liberal arts, academic mathematics, and mathematics content related to the school mathematics curriculum that future lower-secondary teachers experience during their programs (estimated means in hours)

Program-Group	Country	Mean Number of Teaching Contact Hours for Liberal Arts Courses			Mean Number of Teaching Contact Hours for Academic Mathematics			Mean Number of Teaching Contact Hours for Mathematics Content Related to the School Mathematics Curriculum		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Secondary (to Grade 10 Maximum)	Botswana				2	227	(236.8)	2	112	(120.6)
	Chile[†]	33	1,393	(262.9)	10	200	(40.9)	32	213	(33.2)
	Norway (ALU)[†c]	7	446	(55.7)	2	269	(43.1)	14	356	(42.3)
	Norway (ALU+)[†c]	8	471	(47.2)	3	248	(74.7)	15	360	(42.2)
	Philippines[e]	44	54	(3.4)	46	51	(2.4)	26	54	(3.4)
	Poland[†f]	19	184	(24.8)	19	666	(34.3)	16	54	(19.4)
	Singapore	2	0	(0.0)	2	0	(0.0)	2	0	(0.0)
	Switzerland[i]	1	832	(0.0)	4	292	(12.1)	4	79	(74.8)
	United States[†j]	11	272	(130.9)	13	125	(74.2)	9	61	(31.4)
Lower and Upper Secondary (to Grade 11 and above)	Botswana	1	630	(0.0)	1	672	(0.0)	1	462	(0.0)
	Chinese Taipei[a]	7	477	(2.3)	8	642	(290.1)	3	84	(15.0)
	Georgia	6	284	(33.9)	7	893	(114.4)	6	189	(81.6)
	Malaysia[b]	8	438	(30.1)	8	747	(21.4)	8	204	(78.3)
	Norway (PPU & Master's)[c]	0	0	(0.0)	2	134	(21.2)	11	129	(28.6)
	Oman[d]	8	324	(37.6)	4	585	(141.5)	6	174	(77.8)
	Poland[f]	15	149	(14.5)	15	1,310	(85.1)	13	41	(14.2)
	Russian Federation[g]	43	1,468	(140.9)	43	1,857	(164.5)	36	380	(63.1)
	Singapore	2	0	(0.0)	2	0	(0.0)	2	0	(0.0)
	Thailand[†]	34	303	(47.7)	20	343	(49.1)	25	117	(23.9)
	United States[j]	35	499	(52.1)	40	442	(55.5)	30	87	(26.7)

Notes:
1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.3: Mean number of teaching contact hours in mathematics pedagogy, foundations, and pedagogy courses that future primary teachers experience during their programs (estimated means in hours)

Program-Group	Country	Mean Number of Teaching Contact Hours for Mathematics Pedagogy			Mean Number of Teaching Contact Hours for Foundations			Mean Number of Teaching Contact Hours for General Pedagogy		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	10	125	(34.1)	10	396	(74.6)	10	139	(33.5)
	Poland[f]	68	37	(3.1)	59	400	(21.9)	69	272	(23.9)
	Russian Federation[g]	44	303	(29.2)	44	879	(102.1)	44	715	(130.5)
	Switzerland[i]	5	98	(11.9)	6	469	(64.3)	6	507	(221.3)
Primary (to Grade 6 Maximum)	Chinese Taipei[a]	8	22	(9.7)	11	108	(56.2)	11	115	(59.4)
	Philippines[e]	24	58	(3.9)	32	53	(3.9)	32	49	(5.1)
	Singapore	4	102	(2.8)	4	96	(11.3)	4	42	(8.5)
	Spain[h]	44	137	(14.9)	43	328	(22.2)	43	345	(56.1)
	Switzerland[i]	9	76	(8.4)	11	458	(40.9)	13	350	(67.8)
	United States[j]	51	63	(9.4)	52	180	(27.2)	52	347	(34.4)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	2	124	(28.3)	2	186	(72.1)	3	32	(16.9)
	Chile[†]	29	145	(14.8)	28	515	(75.9)	28	904	(147.1)
	Norway (ALU)[†c]	14	356	(42.3)	11	272	(40.1)	11	272	(40.1)
	Norway (ALU+)[†c]	15	360	(42.2)	11	295	(57.1)	11	295	(57.1)
Primary Mathematics Specialists	Malaysia[b]	10	118	(17.9)	7	122	(43.7)	10	103	(16.1)
	Poland[†f]	35	115	(8.3)	35	73	(6.6)	33	63	(3.9)
	Singapore	2	108	(8.5)	2	72	(0.0)	2	24	(0.0)
	Thailand[†]	31	159	(33.7)	29	284	(48.7)	30	152	(37.3)
	United States[†j]	14	52	(12.7)	14	96	(34.8)	14	166	(89.9)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.4: Mean number of teaching contact hours in mathematics pedagogy, foundations, and pedagogy courses that future lower-secondary teachers experience during their programs (estimated means in hours)

Program-Group	Country	Mean Number of Teaching Contact Hours for Mathematics Pedagogy			Mean Number of Teaching Contact Hours for Foundations			Mean Number of Teaching Contact Hours for General Pedagogy		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Secondary (to Grade 10 Maximum)	Botswana	2	112	(120.6)	1	3	(0.0)	1	3	(0.0)
	Chile[†]	36	149	(15.5)	35	560	(101.3)	35	730	(109.8)
	Norway (ALU)[†c]	14	356	(42.3)	11	272	(40.1)	11	272	(40.1)
	Norway (ALU+)[†c]	15	360	(42.2)	11	295	(57.1)	11	295	(57.1)
	Philippines[e]	35	53	(3.3)	45	52	(2.6)	41	50	(3.1)
	Poland[†f]	20	108	(10.6)	20	64	(6.9)	20	66	(6.0)
	Singapore	2	108	(0.0)	2	72	(0.0)	2	48	(0.0)
	Switzerland[i]	6	163	(121.7)	4	193	(53.6)	5	332	(143.6)
	United States[†j]	14	52	(12.7)	14	96	(34.8)	14	166	(89.9)
Lower and Upper Secondary (to Grade 11 and above)	Botswana	1	220	(0.0)	1	168	(0.0)	1	84	(0.0)
	Chinese Taipei[a]	8	95	(7.1)	8	112	(13.0)	8	169	(43.7)
	Georgia	6	100	(19.3)	5	281	(109.0)	6	101	(15.5)
	Malaysia[b]	8	138	(10.0)	8	370	(8.9)	8	121	(7.2)
	Norway (PPU & Master's)[c]	11	129	(28.6)	8	110	(4.9)	8	110	(4.9)
	Oman[d]	8	107	(36.1)	8	230	(32.0)	5	123	(69.6)
	Poland[f]	15	124	(12.9)	15	84	(13.3)	13	60	(3.3)
	Russian Federation[g]	42	278	(23.3)	41	602	(70.7)	43	346	(52.4)
	Singapore	2	108	(0.0)	2	72	(0.0)	2	48	(0.0)
	Thailand[†]	31	159	(33.7)	29	284	(48.7)	30	152	(37.3)
	United States[j]	44	72	(6.2)	46	144	(27.3)	44	145	(20.6)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.5: Graduation requirements for future primary teachers (estimated percent) (Part 1)

Program-Group	Country	Passing Grade on all Subjects			Comprehensive Written Examination			Comprehensive Oral Examination			National or State Examination		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	10	100.0	(0.0)	10	20.0	(14.1)	10	70.0	(10.0)	10	30.0	(10.0
	Poland[f]	85	100.0	(0.0)	85	4.7	(2.4)	84	23.8	(3.8)	85	9.4	(3.3)
	Russian Federation[g]	45	100.0	(0.0)	44	12.1	(4.3)	45	91.9	(3.8)	45	53.1	(12.7)
	Switzerland[i]	7	100.0	(0.0)	7	85.7	(20.2)	7	71.4	(24.7)	7	0.0	(0.0)
Primary (to Grade 6 Maximum)	Chinese Taipei[a]	11	100.0	(0.0)	10	94.3	(5.4)	10	77.1	(10.7)	10	82.8	(9.5)
	Philippines[e]	33	94.0	(6.1)	33	59.0	(11.3)	33	35.4	(9.2)	31	50.0	(13.1)
	Singapore	4	100.0	(0.0)	4	0.0	(0.0)	4	0.0	(0.0)	4	0.0	(0.0)
	Spain[h]	48	98.1	(1.9)	48	6.7	(2.0)	48	0.0	(0.0)	48	1.4	(1.4)
	Switzerland[i]	14	100.0	(0.0)	14	64.3	(16.0)	14	71.4	(10.1)	14	7.1	(7.1)
	United States[j]	54	100.0	(0.0)	54	44.6	(6.2)	54	10.7	(4.8)	54	88.7	(4.9)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	4	100.0	(0.0)	4	100.0	(0.0)	3	0.0	(0.0)	4	50.0	(35.4)
	Chile†	31	100.0	(0.0)	31	22.6	(7.9)	31	41.9	(9.4)	31	9.7	(6.5)
	Norway (ALU)†[c]	16	100.0	(0.0)	15	60.0	(7.8)	15	60.0	(7.8)	15	0.0	(0.0)
	Norway (ALU+)†[c]	16	100.0	(0.0)	16	62.5	(8.8)	15	66.7	(10.4)	16	0.0	(0.0)
Primary Mathematics Specialists	Malaysia[b]	12	100.0	(0.0)	12	91.7	(8.3)	12	25.0	(14.4)	12	91.7	(8.3)
	Poland†[f]	38	100.0	(0.0)	38	7.9	(2.7)	37	54.1	(8.8)	38	10.5	(5.4)
	Singapore	2	100.0	(0.0)	2	0.0	(0.0)	2	0.0	(0.0)	2	0.0	(0.0)
	Thailand†	48	100.0	(0.0)	46	67.3	(7.9)	46	23.9	(5.8)	47	12.8	(3.1)
	United States†[j]	15	100.0	(0.0)	15	26.3	(16.9)	15	0.0	(0.0)	15	61.6	(17.3)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.6: Graduation requirements for future primary teachers (estimated percent) (Part 2)

Program-Group	Country	Examination Set by Program			Teaching Competence			Field Experience			Thesis		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	10	60.0	(14.1)	10	60.0	(14.1)	10	90.0	(10.0)	10	20.0	(14.1)
	Poland[f]	85	80.0	(3.9)	85	62.4	(6.3)	85	100.0	(0.0)	85	95.3	(1.7)
	Russian Federation[g]	45	95.9	(2.5)	45	94.6	(0.8)	45	100.0	(0.0)	45	100.0	(0.0)
	Switzerland[i]	7	100.0	(0.0)	7	100.0	(0.0)	7	100.0	(0.0)	7	100.0	(0.0)
Primary (to Grade 6 Maximum)	Chinese Taipei[a]	11	59.4	(23.7)	11	89.2	(6.4)	11	100.0	(0.0)	11	5.4	(5.1)
	Philippines[e]	33	70.0	(9.5)	33	91.5	(6.9)	33	94.0	(6.1)	33	70.5	(12.0)
	Singapore	4	0.0	(0.0)	4	100.0	(0.0)	4	100.0	(0.0)	4	0.0	(0.0)
	Spain[h]	48	5.3	(1.4)	47	36.4	(11.5)	48	52.2	(11.5)	48	0.0	(0.0)
	Switzerland[i]	14	85.7	(10.1)	14	100.0	(0.0)	14	100.0	(0.0)	14	100.0	(0.0)
	United States[j]	54	35.6	(10.5)	54	100.0	(0.0)	54	100.0	(0.0)	54	10.4	(6.0)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	3	66.7	(19.0)	4	100.0	(0.0)	4	100.0	(0.0)	4	50.0	(35.4)
	Chile†	31	38.7	(10.7)	31	67.7	(9.9)	31	100.0	(0.0)	31	80.6	(8.5)
	Norway (ALU)†[c]	16	87.5	(8.8)	16	100.0	(0.0)	16	100.0	(0.0)	16	0.0	(0.0)
	Norway (ALU+)†[c]	16	87.5	(8.8)	16	93.8	(6.3)	16	100.0	(0.0)	16	0.0	(0.0)
Primary Mathematics Specialists	Malaysia[b]	12	83.3	(11.8)	12	100.0	(0.0)	12	100.0	(0.0)	12	8.3	(8.3)
	Poland†[f]	36	75.0	(6.6)	36	47.2	(9.8)	38	100.0	(0.0)	37	86.5	(5.9)
	Singapore	2	0.0	(0.0)	2	100.0	(0.0)	2	100.0	(0.0)	2	0.0	(0.0)
	Thailand†	46	69.5	(6.2)	47	89.4	(4.1)	47	97.9	(2.1)	47	14.9	(4.8)
	United States†[j]	15	19.6	(16.4)	15	100.0	(0.0)	15	100.0	(0.0)	15	0.0	(0.0)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.7: Graduation requirements for future lower-secondary teachers (estimated percent) (Part 1)

Program-Group	Country	Passing Grade on all Subjects			Comprehensive Written Examination			Comprehensive Oral Examination			National or State Examination		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Secondary (to Grade 10 maximum)	Botswana	2	100.0	(0.0)	2	100.0	(0.0)	2	0.0	(0.0)	2	50.0	(55.6)
	Chile[†]	38	100.0	(0.0)	38	27.9	(6.4)	38	45.9	(10.2)	38	7.1	(4.8)
	Norway (ALU)[†c]	16	100.0	(0.0)	15	60.0	(7.8)	15	60.0	(7.8)	15	0.0	(0.0)
	Norway (ALU+)[†c]	16	100.0	(0.0)	16	62.5	(8.8)	15	66.7	(10.4)	16	0.0	(0.0)
	Philippines[e]	47	98.6	(1.5)	47	64.5	(6.1)	47	45.9	(6.2)	46	56.6	(7.2)
	Poland[†f]	21	100.0	(0.0)	21	9.5	(0.5)	21	66.7	(12.2)	21	4.8	(4.8)
	Singapore	2	100.0	(0.0)	2	0.0	(0.0)	2	0.0	(0.0)	2	0.0	(0.0)
	Switzerland[i]	7	100.0	(0.0)	7	85.7	(14.3)	7	85.7	(14.3)	7	0.0	(0.0)
	United States[†j]	15	100.0	(0.0)	15	26.3	(16.9)	15	0.0	(0.0)	15	61.6	(17.3)
Lowe and Upper Secondary (to Grade 11 and above)	Botswana	1	100.0	(0.0)	1	100.0	(0.0)	1	0.0	(0.0)	1	0.0	(0.0)
	Chinese Taipei[a]	8	100.0	(0.0)	8	81.0	(0.0)	8	85.7	(4.8)	8	59.5	(36.0)
	Georgia	7	100.0	(0.0)	7	28.6	(17.5)	7	42.9	(17.5)	7	28.6	(10.1)
	Malaysia	8	100.0	(0.0)	8	87.5	(12.5)	8	0.0	(0.0)	8	0.0	(0.0)
	Norway (PPU & Master's)[c]	11	100.0	(0.0)	11	91.0	(9.0)	11	72.8	(14.3)	11	0.0	(0.0)
	Oman[d]	8	100.0	(0.0)	8	37.5	(12.5)	8	0.0	(0.0)	8	0.0	(0.0)
	Poland[f]	17	100.0	(0.0)	17	5.9	(5.9)	16	37.5	(11.3)	17	17.6	(10.9)
	Russian Federation[g]	43	97.2	(2.8)	43	14.0	(6.0)	43	71.8	(8.6)	42	70.4	(9.2)
	Singapore	2	100.0	(0.0)	2	0.0	(0.0)	2	0.0	(0.0)	2	0.0	(0.0)
	Thailand[†]	48	100.0	(0.0)	46	67.3	(7.9)	46	23.9	(5.8)	47	12.8	(3.1)
	United States[j]	46	100.0	(0.0)	46	32.3	(7.1)	46	14.1	(7.4)	46	81.5	(9.7)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.8: Graduation requirements for future lower-secondary teachers (estimated percent) (Part 2)

Program-Group	Country	Examination Set by Program			Teaching Competence			Field Experience			Thesis		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Secondary (to Grade 10 maximum)	Botswana	2	100.0	(0.0)	2	100.0	(0.0)	2	100.0	(0.0)	2	50.0	(55.6)
	Chile[†]	38	32.3	(8.7)	38	68.7	(9.0)	38	100.0	(0.0)	38	82.0	(6.8)
	Norway (ALU)[†c]	16	87.5	(8.8)	16	100.0	(0.0)	16	100.0	(0.0)	16	0.0	(0.0)
	Norway (ALU+)[†c]	16	87.5	(8.8)	16	93.8	(6.3)	16	100.0	(0.0)	16	0.0	(0.0)
	Philippines[e]	47	82.7	(6.4)	47	98.6	(1.5)	47	98.6	(1.5)	47	77.4	(5.4)
	Poland[†f]	20	75.0	(8.1)	20	45.0	(10.6)	21	100.0	(0.0)	20	80.0	(9.6)
	Singapore	2	0.0	(0.0)	2	100.0	(0.0)	2	100.0	(0.0)	2	0.0	(0.0)
	Switzerland[i]	7	85.7	(14.3)	7	100.0	(0.0)	7	100.0	(0.0)	7	85.7	(10.1)
	United States[†j]	15	19.6	(16.4)	15	100.0	(0.0)	15	100.0	(0.0)	15	0.0	(0.0)
Lower and Upper Secondary (to Grade 11 and above)	Botswana	1	100.0	(0.0)	1	100.0	(0.0)	1	100.0	(0.0)	1	0.0	(0.0)
	Chinese Taipei[a]	8	90.5	(0.0)	8	54.8	(36.3)	8	100.0	(0.0)	8	0.0	(0.0)
	Georgia	7	42.9	(17.5)	7	57.1	(22.6)	7	85.7	(14.3)	7	42.9	(10.1)
	Malaysia[b]	8	87.5	(12.5)	8	100.0	(0.0)	8	100.0	(0.0)	8	87.5	(12.5)
	Norway (PPU & Master's)[c]	11	100.0	(0.0)	11	72.3	(16.0)	11	63.1	(13.1)	11	46.2	(0.0)
	Oman[d]	8	37.5	(12.5)	8	75.0	(17.7)	8	87.5	(12.5)	8	12.5	(12.5)
	Poland[f]	16	75.0	(10.8)	16	50.0	(17.6)	17	100.0	(0.0)	17	94.1	(5.9)
	Russian Federation[g]	41	87.4	(5.5)	43	65.3	(7.4)	43	97.9	(2.1)	43	97.9	(2.1)
	Singapore	2	0.0	(0.0)	2	100.0	(0.0)	2	100.0	(0.0)	2	0.0	(0.0)
	Thailand[†]	46	69.5	(6.2)	47	89.4	(4.1)	47	97.9	(2.1)	47	14.9	(4.8)
	United States[j]	46	30.7	(9.4)	46	100.0	(0.0)	46	97.7	(2.3)	46	5.5	(3.7)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.9: Locus of control of performance standards in teacher education (estimated percent)

Program-Group	Country	National Government			State Government			Institution or Program			Availability of a Standard Document		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	3	66.7	(28.4)	3	33.3	(28.4)	3	100.0	(0.0)	3	66.7	(28.4)
	Poland[f]	69	79.7	(5.3)	69	5.8	(2.1)	69	79.7	(5.8)	0	0.0	(0.0)
	Russian Federation[g]	44	94.6	(4.0)	44	0.0	(0.0)	44	31.4	(7.4)	44	0.0	(0.0)
	Switzerland[i]	7	0.0	(0.0)	7	14.3	(14.3)	7	100.0	(0.0)	6	0.0	(0.0)
Primary (to Grade 6 Maximum)	Chinese Taipei[a]	4	15.4	(21.8)	4	0.0	(0.0)	4	84.6	(21.8)	3	0.0	(0.0)
	Philippines[e]	24	61.8	(13.1)	24	27.2	(11.5)	24	65.7	(14.5)	22	0.9	(0.7)
	Singapore	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)
	Spain[h]	13	51.3	(14.1)	14	53.3	(13.2)	14	46.9	(13.3)	14	13.5	(12.3)
	Switzerland[i]	13	0.0	(0.0)	13	15.4	(11.4)	13	100.0	(0.0)	13	0.0	(0.0)
	United States[j]	53	23.0	(8.9)	53	91.5	(5.5)	53	90.0	(3.9)	45	1.5	(0.2)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana	3	100.0	(0.0)	3	0.0	(0.0)	3	66.7	(42.2)	3	33.3	(26.7)
	Chile[†]	28	42.9	(7.9)	29	20.7	(8.5)	29	79.3	(7.0)	25	16.0	(7.9)
	Norway (ALU)[†c]	16	87.5	(8.8)	16	12.5	(8.8)	15	87.5	(8.8)	0	0.0	(0.0)
	Norway (ALU+)[†c]	15	86.7	(9.5)	15	13.3	(9.5)	16	86.7	(8.8)	0	0.0	(0.0)
Primary Mathematics Specialists	Malaysia[b]	5	100.0	(0.0)	5	20.0	(17.4)	5	20.0	(17.4)	5	0.0	(0.0)
	Poland[†f]	30	90.0	(5.8)	30	3.3	(3.5)	30	46.7	(9.3)	0	0.0	(0.0)
	Singapore	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)
	Thailand[†]	27	44.5	(9.0)	27	18.6	(6.8)	27	70.3	(8.7)	27	0.0	(0.0)
	United States[†j]	13	12.6	(17.3)	13	90.9	(6.8)	13	100.0	(0.0)	13	3.4	(3.9)
Lower Secondary (to Grade 10 Maximum)	Botswana	2	0.0	(0.0)	2	0.0	(0.0)	2	100.0	(0.0)	2	0.0	(0.0)
	Chile[†]	34	40.5	(6.8)	35	27.9	(10.1)	35	76.2	(5.4)	30	17.0	(7.7)
	Norway (ALU)[†c]	16	87.5	(8.8)	16	12.5	(8.8)	16	87.5	(8.8)	0	0.0	(0.0)
	Norway (ALU+)[†c]	15	86.7	(9.5)	15	13.3	(9.5)	15	86.7	(8.8)	0	0.0	(0.0)
	Philippines[e]	36	65.0	(10.0)	36	41.3	(15.6)	36	57.3	(9.9)	33	0.5	(0.4)
	Poland[†f]	17	94.1	(5.9)	17	0.0	(0.0)	17	47.1	(12.2)	0	0.0	(0.0)
	Singapore	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)
	Switzerland[i]	6	0.0	(0.0)	6	0.0	(0.0)	6	100.0	(0.0)	5	20.0	(21.4)
	United States[†j]	13	12.6	(17.3)	13	90.9	(6.8)	13	100.0	(0.0)	13	3.4	(3.9)

Exhibit A4.9: Locus of control of performance standards in teacher education (estimated percent) (contd.)

Program-Group	Country	National Government			State Government			Institution or Program			Availability of a Standard Document		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower and Upper Secondary (to Grade 11 and above)	Botswana	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)
	Chinese Taipei[a]	2	88.2	(18.4)	2	0.0	(0.0)	2	100.0	(0.0)	2	0.0	(0.0)
	Georgia	4	50.0	(26.2)	4	0.0	(0.0)	4	100.0	(0.0)	4	0.0	(0.0)
	Malaysia[b]	7	100.0	(0.0)	7	0.0	(0.0)	7	14.3	(14.5)	7	0.0	(0.0)
	Norway (PPU & Master's)[c]	9	66.4	(15.9)	9	0.0	(0.0)	9	78.0	(16.4)	0	0.0	(0.0)
	Oman[d]	7	57.1	(14.5)	7	0.0	(0.0)	7	57.1	(14.5)	7	14.3	(13.5)
	Poland[f]	13	84.6	(11.2)	13	7.7	(8.5)	13	46.2	(13.6)	0	0.0	(0.0)
	Russian Federation[g]	42	95.6	(3.1)	42	14.2	(7.1)	42	47.4	(9.4)	42	1.3	(1.3)
	Singapore	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)	0	0.0	(0.0)
	Thailand†	27	44.5	(9.0)	27	18.6	(6.8)	27	70.3	(8.7)	27	0.0	(0.0)
	United States[j]	39	13.1	(6.2)	39	87.0	(7.7)	39	73.1	(7.9)	35	1.1	(1.2)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.10: Teacher educators' qualifications in mathematics, by disciplines taught (estimated percent)

Country	Master's-Level Qualifications in Mathematics									Doctoral-Level Qualifications in Mathematics								
	A. Mathematics and Mathematics Pedagogy Teacher Educators			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*			*A. Mathematics and Mathematics Pedagogy Teacher Educators*			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*		
	n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Botswana	12	58.3	(12.4)	7	0.0	(0.0)	0	0.0	(0.0)	12	16.7	(11.1)	7	0.0	(0.0)	0	0.0	(0.0)
Chile[a]	65	8.9	(4.2)	64	3.2	(2.8)	26	11.9	(6.8)	65	4.7	(2.8)	64	3.9	(2.8)	26	5.2	(5.3)
Chinese Taipei	74	11.0	(3.2)	58	1.4	(1.4)	1	0.0	(0.0)	74	64.9	(9.7)	58	0.0	(0.0)	1	0.0	(0.0)
Georgia	36	16.2	(5.7)	8	12.5	(11.2)	0	0.0	(0.0)	36	62.2	(6.0)	8	12.5	(13.1)	0	0.0	(0.0)
Germany[b]	110	0.0	(0.0)	135	25.3	(7.9)	131	68.0	(9.9)	110	88.0	(3.1)	135	0.0	(0.0)	131	10.3	(3.3)
Malaysia[c]	119	14.5	(3.0)	6	0.0	(0.0)	40	6.8	(4.0)	119	0.8	(1.1)	6	18.8	(15.7)	40	30.6	(5.8)
Oman[d]	45	1.8	(1.8)	9	0.0	(0.0)	2	100.0	(0.0)	45	82.6	(3.7)	9	0.0	(0.0)	2	0.0	(0.0)
Philippines	167	43.0	(5.6)	165	6.4	(3.1)	81	25.7	(8.3)	167	7.1	(4.0)	165	1.3	(1.3)	81	1.2	(0.8)
Poland[e]	440	23.0	(1.8)	135	4.5	(1.7)	18	48.5	(14.5)	440	71.6	(1.7)	135	1.2	(0.9)	18	24.2	(10.7)
Russian Federation[f]	814	55.3	(2.6)	150	43.2	(6.3)	12	43.8	(11.9)	814	35.5	(2.6)	150	0.0	(0.0)	12	3.0	(3.1)
Singapore	21	4.8	(3.4)	32	0.0	(0.0)	0	0.0	(0.0)	21	42.9	(7.6)	32	0.0	(0.0)	0	0.0	(0.0)
Spain[g]	111	69.1	(5.4)	249	2.4	(0.7)	9	16.9	(21.6)	111	17.5	(4.3)	249	0.0	(0.0)	9	0.0	(0.0)
Switzerland[h]	46	33.1	(7.0)	118	0.0	(0.0)	1	0.0	(0.0)	46	8.7	(4.1)	118	0.0	(0.0)	1	100.0	(0.0)
Thailand	82	52.1	(5.8)	51	3.8	(2.4)	40	28.4	(6.0)	82	11.8	(2.7)	51	0.0	(0.0)	40	4.6	(2.9)

Notes:

1. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.11: Teacher educators' qualifications in mathematics education, by disciplines taught (estimated percent)

Country	Master's-Level Qualifications in Mathematics Education									Doctoral-Level Qualifications in Education								
	A. Mathematics and Mathematics Pedagogy Teacher Educators			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. And B.*			*A. Mathematics and Mathematics Pedagogy Teacher Educators*			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*		
	n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Botswana	9	88.9	(10.8)	7	0.0	(0.0)	0	0.0	(0.0)	9	11.1	(10.8)	7	0.0	(0.0)	0	0.0	(0.0)
Chile[a]	49	27.5	(7.2)	58	4.4	(3.3)	19	6.3	(6.1)	49	2.8	(2.8)	58	0.0	(0.0)	19	6.5	(6.8)
Chinese Taipei	60	11.9	(4.2)	58	3.0	(2.7)	2	50.0	(55.6)	60	23.9	(11.0)	58	1.4	(1.4)	2	0.0	(0.0)
Georgia	28	25.6	(4.4)	5	0.0	(0.0)	0	0.0	(0.0)	28	41.9	(6.1)	5	0.0	(0.0)	0	0.0	(0.0)
Germany[b]	75	2.6	(2.6)	132	28.2	(5.2)	113	43.9	(7.9)	75	0.0	(0.0)	132	0.2	(0.3)	113	16.6	(5.4)
Malaysia[c]	105	33.7	(4.3)	5	7.3	(7.6)	23	7.0	(4.6)	105	7.9	(2.2)	5	23.2	(19.5)	23	9.8	(7.5)
Oman[d]	28	4.2	(4.1)	7	0.0	(0.0)	2	0.0	(0.0)	28	16.6	(3.9)	7	14.1	(12.9)	2	0.0	(0.0)
Philippines	158	58.5	(5.5)	163	12.0	(4.0)	78	25.9	(6.8)	158	5.9	(2.8)	163	1.1	(0.7)	78	5.2	(2.1)
Poland[e]	315	21.4	(2.1)	128	3.4	(2.3)	14	32.0	(15.3)	315	10.3	(1.6)	128	0.6	(0.9)	14	8.0	(6.4)
Russian Federation[f]	724	47.5	(4.3)	148	37.8	(6.5)	13	39.4	(11.7)	724	24.9	(2.8)	148	6.3	(2.8)	13	22.6	(13.9)
Singapore	21	57.1	(9.3)	28	10.7	(6.0)	0	0.0	(0.0)	21	28.6	(9.0)	28	0.0	(0.0)	0	0.0	(0.0)
Spain[g]	90	10.6	(2.9)	245	3.7	(1.5)	8	0.0	(0.0)	90	31.0	(5.3)	245	0.0	(0.0)	8	0.0	(0.0)
Switzerland[h]	43	17.5	(6.3)	116	0.7	(0.7)	1	0.0	(0.0)	43	7.3	(4.2)	116	0.0	(0.0)	1	0.0	(0.0)
Thailand	81	34.4	(4.9)	42	4.6	(2.8)	46	39.6	(8.5)	81	14.5	(4.2)	42	0.0	(0.0)	46	21.3	(6.9)

Notes:
1. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.12: Teacher educators' qualifications in education, by disciplines taught (estimated percent female)

Country	Master's-Level Qualifications in Mathematics Education									Doctoral-Level Qualifications in Mathematics Education								
	A. Mathematics and Mathematics Pedagogy Teacher Educators			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*			*A. Mathematics and Mathematics Pedagogy Teacher Educators*			*B. General Pedagogy Teacher Educators*			*Teacher Educators of Both Areas A. and B.*		
	n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Botswana	6	50.0	(26.2)	19	89.7	(7.5)	0	0.0	(0.0)	6	16.7	(16.3)	19	5.1	(5.2)	0	0.0	(0.0)
Chile[a]	62	50.7	(5.9)	201	50.4	(3.8)	47	48.6	(6.6)	62	5.2	(2.9)	201	16.5	(2.2)	47	23.7	(5.6)
Chinese Taipei	51	1.3	(0.9)	94	27.6	(3.5)	1	0.0	(0.0)	51	6.3	(2.9)	94	63.3	(3.1)	1	100.0	(0.0)
Georgia	20	9.7	(1.5)	20	15.0	(8.7)	1	0.0	(0.0)	20	14.5	(7.3)	20	70.0	(11.7)	1	100.0	(0.0)
Germany[b]	76	1.3	(1.3)	193	49.6	(9.9)	107	46.9	(8.0)	76	0.0	(0.0)	193	25.0	(5.1)	107	10.2	(6.4)
Malaysia[c]	102	46.5	(5.2)	13	38.4	(13.9)	48	50.2	(6.7)	102	5.4	(2.5)	13	48.7	(14.2)	48	8.7	(4.8)
Oman[d]	29	5.3	(3.2)	15	12.8	(8.4)	2	0.0	(0.0)	29	9.4	(5.3)	15	74.8	(11.5)	2	0.0	(0.0)
Philippines	142	31.9	(4.4)	253	33.2	(3.3)	96	48.5	(7.6)	142	18.9	(3.7)	253	37.7	(6.2)	96	23.2	(6.2)
Poland[e]	308	9.4	(1.6)	239	35.4	(3.0)	20	21.1	(11.3)	308	6.6	(1.1)	239	60.9	(3.4)	20	47.4	(10.0)
Russian Federation[f]	662	48.6	(3.8)	250	16.1	(3.5)	13	7.8	(6.1)	662	16.9	(1.9)	250	78.4	(4.2)	13	81.0	(18.5)
Singapore	16	31.3	(9.8)	45	33.3	(6.4)	0	0.0	(0.0)	16	6.3	(6.1)	45	44.4	(7.5)	0	0.0	(0.0)
Spain[g]	71	7.7	(3.0)	310	30.8	(2.3)	10	39.2	(7.9)	71	1.0	(0.7)	310	35.2	(2.4)	10	11.4	(5.2)
Switzerland[h]	39	9.5	(5.2)	149	52.7	(4.7)	1	0.0	(0.0)	39	7.2	(4.2)	149	28.0	(3.6)	1	0.0	(0.0)
Thailand	56	24.0	(4.8)	91	67.9	(5.3)	37	55.0	(6.7)	56	3.4	(2.7)	91	24.6	(5.0)	37	18.7	(8.6)

Notes:
1. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
2. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.13: Future primary teachers' level of achievement during secondary school (estimated percent)

Program-Group	Country		Percent of Future Primary Teachers in Response Categories (weighted estimates)									
			Always at the Top of My Year Level		*Usually Near the Top of My Year Level*		*Generally Above Average for My Year Level*		*Generally About Average for My Year Level*		*Generally Below Average for My Year Level*	
		n	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Lower Primary (to Grade 4 Maximum)	Georgia	461	9.0	(1.7)	41.5	(2.5)	31.8	(1.9)	17.4	(1.8)	0.2	(0.2)
	Germany	929	0.1	(0.1)	12.8	(1.5)	31.7	(2.2)	45.0	(2.3)	10.3	(1.1)
	Poland[d]	1,806	1.9	(0.3)	13.8	(0.9)	35.9	(1.0)	47.2	(1.3)	1.2	(0.3)
	Russian Federation[e]	2,258	9.7	(1.3)	35.4	(1.8)	35.0	(1.9)	19.7	(1.6)	0.3	(0.1)
	Switzerland[f]	119	1.0	(1.0)	20.3	(2.9)	37.1	(5.9)	33.6	(4.7)	7.9	(2.9)
Primary (to Grade 6 Maximum)	Chinese Taipei	923	15.4	(1.5)	23.8	(1.7)	33.8	(1.8)	21.4	(2.2)	5.6	(0.9)
	Philippines	575	3.9	(0.7)	14.8	(2.5)	37.3	(2.9)	43.7	(4.2)	0.2	(0.1)
	Singapore	263	6.5	(1.8)	19.4	(2.8)	44.4	(3.2)	27.4	(3.2)	2.3	(0.8)
	Spain	1,080	11.6	(0.9)	12.8	(1.3)	19.6	(1.6)	49.5	(2.0)	6.5	(0.7)
	Switzerland[f]	812	1.6	(0.4)	31.6	(1.8)	30.6	(1.5)	29.2	(1.3)	7.0	(0.9)
	United States[g]	1,030	15.5	(1.4)	36.7	(1.9)	30.0	(1.6)	16.3	(1.3)	1.5	(0.5)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[a]	64	0.0	(0.0)	22.9	(4.8)	45.8	(6.5)	31.3	(5.6)	0.0	(0.0)
	Chile[†b]	651	15.1	(1.3)	25.8	(1.5)	23.8	(1.5)	31.8	(1.4)	3.6	(0.7)
	Norway (ALU)[†c]	390	2.6	(0.9)	32.6	(2.6)	37.6	(1.9)	24.5	(2.2)	2.7	(1.0)
	Norway (ALU+)[†c]	156	5.3	(1.8)	25.7	(4.3)	44.1	(5.2)	24.3	(3.3)	0.5	(0.4)
Primary Mathematics Specialists	Germany[†]	94	0.2	(0.2)	21.6	(7.7)	47.0	(5.9)	29.6	(7.2)	1.7	(1.5)
	Malaysia	570	21.6	(1.6)	36.3	(2.1)	28.3	(1.9)	11.7	(1.2)	2.1	(0.8)
	Poland[†d]	300	6.0	(1.4)	41.8	(3.6)	35.0	(4.0)	15.5	(2.3)	1.7	(0.9)
	Singapore	117	7.4	(2.2)	17.7	(3.5)	50.0	(4.7)	23.1	(3.7)	1.7	(1.7)
	Thailand[†]	660	6.4	(1.0)	37.9	(1.4)	38.2	(1.7)	17.0	(1.3)	0.4	(0.3)
	United States[†g]	151	16.8	(3.2)	34.7	(4.4)	31.9	(4.5)	12.1	(2.8)	4.4	(2.7)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.14: Future lower-secondary teachers' level of achievement in secondary school (estimated percent)

Program-Group	Country	n	Always at the Top of My Year Level Est.	(SE)	Usually Near the Top of My Year Level Est.	(SE)	Generally Above Average for My Year Level Est.	(SE)	Generally About Average for My Year Level Est.	(SE)	Generally Below Average for My Year Level Est.	(SE)
Lower Secondary (to Grade 10 Maximum)	Botswana[a]	30	6.6	(4.6)	60.0	(10.1)	23.3	(7.5)	10.0	(5.7)	0.0	(0.0)
	Chile†[b]	740	16.3	(1.4)	25.6	(1.5)	24.2	(1.6)	31.1	(1.9)	2.7	(0.6)
	Germany†	405	1.8	(0.7)	29.7	(4.7)	32.3	(4.8)	31.8	(3.8)	4.4	(1.2)
	Norway (ALU)†[d]	354	4.3	(1.0)	32.3	(2.2)	34.5	(2.4)	25.6	(2.5)	3.2	(0.9)
	Norway (ALU+)†[d]	146	7.0	(1.8)	29.9	(3.3)	35.2	(5.0)	26.6	(4.2)	1.4	(1.2)
	Philippines	704	12.9	(2.2)	20.1	(2.2)	36.6	(3.2)	30.3	(2.7)	0.0	(0.0)
	Poland†[e]	158	8.4	(2.0)	36.2	(4.0)	37.0	(3.4)	18.3	(3.3)	0.0	(0.0)
	Singapore	141	9.8	(3.0)	31.8	(3.9)	37.0	(4.1)	19.4	(4.1)	2.1	(1.2)
	Switzerland[g]	140	3.4	(1.4)	54.8	(4.8)	24.4	(3.0)	12.8	(2.5)	4.6	(1.9)
	United States†[h]	131	17.3	(4.7)	39.5	(4.3)	21.8	(5.4)	21.3	(3.9)	0.2	(0.2)
Lower and Upper Secondary (to Grade 10 and above)	Botswana†[h]	10	30.0	(15.9)	50.0	(19.6)	20.0	(16.0)	0.0	(0.0)	0.0	(0.0)
	Chinese Taipei	364	25.8	(2.2)	30.4	(2.3)	29.4	(2.3)	11.0	(1.7)	3.4	(1.0)
	Georgia[c]	72	24.9	(5.3)	52.3	(6.2)	15.1	(3.4)	7.7	(3.6)	0.0	(0.0)
	Germany	361	9.2	(1.9)	57.9	(3.6)	23.8	(2.8)	7.4	(1.7)	1.6	(1.0)
	Malaysia	388	26.6	(2.1)	36.3	(2.6)	25.8	(2.4)	11.2	(1.7)	0.0	(0.0)
	Norway (PPU & Master's)[d]	64	14.8	(3.8)	47.6	(6.8)	22.0	(5.9)	12.4	(4.3)	3.3	(2.3)
	Oman	258	67.5	(2.8)	26.6	(2.5)	5.9	(1.4)	0.0	(0.0)	0.0	(0.0)
	Poland[e]	139	11.1	(5.0)	38.7	(5.7)	37.7	(6.6)	12.5	(3.5)	0.0	(0.0)
	Russian Federation[f]	2,137	22.4	(1.6)	42.7	(1.3)	25.2	(1.7)	9.5	(1.4)	0.3	(0.2)
	Singapore	250	20.0	(2.2)	36.0	(2.8)	34.4	(2.6)	8.4	(2.2)	1.2	(0.7)
	Thailand†	650	5.2	(0.9)	37.1	(2.0)	40.5	(1.7)	16.5	(1.4)	0.8	(0.4)
	United States[h]	370	29.4	(2.7)	42.8	(2.5)	19.3	(2.6)	7.2	(2.0)	1.3	(0.6)

Percentage of Future Lower-Secondary Teachers in Response Categories (weighted estimates)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.15: Future primary teachers' estimates of the number of books in their parents' or guardians' homes (estimated percent)

Program-Group	Country		Percent of Future Primary Teachers in Response Categories (weighted estimates)									
			None or Few		*Enough to Fill One Bookshelf*		*Enough to Fill One Bookcase*		*Enough to Fill Two Bookcases*		*Enough to Fill Three or More Book Cases*	
		n	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*	Est.	*(SE)*
Lower Primary (to Grade 4 Maximum)	Georgia	497	1.3	(0.5)	9.6	(1.2)	31.1	(2.2)	29.7	(2.2)	28.2	(1.9)
	Germany	835	1.0	(0.6)	4.1	(1.0)	13.3	(1.7)	17.2	(1.6)	64.4	(2.6)
	Poland[d]	1,809	4.0	(0.8)	15.3	(1.2)	40.3	(1.3)	22.9	(1.6)	17.5	(1.3)
	Russian Federation[e]	2,246	1.3	(0.3)	8.0	(1.0)	36.1	(1.7)	33.7	(1.9)	20.9	(1.4)
	Switzerland[f]	121	1.0	(1.0)	1.6	(1.1)	25.7	(4.7)	26.5	(4.1)	45.3	(4.4)
Primary (to Grade 6 Maximum)	Chinese Taipei	923	6.6	(0.9)	12.6	(0.9)	31.8	(1.2)	19.5	(1.3)	29.5	(1.6)
	Philippines	591	31.2	(2.8)	46.7	(3.4)	18.4	(5.2)	2.8	(0.9)	0.9	(0.3)
	Singapore	263	3.9	(1.1)	15.2	(2.4)	36.2	(3.0)	20.4	(2.4)	24.4	(2.7)
	Spain	1,093	0.5	(0.2)	6.6	(0.8)	30.8	(2.4)	27.1	(1.8)	35.0	(1.4)
	Switzerland[r]	815	1.7	(0.4)	3.4	(0.5)	20.4	(1.5)	29.2	(1.8)	45.3	(1.9)
	United States[g]	1,035	2.4	(0.6)	9.5	(1.2)	28.7	(1.9)	22.0	(1.2)	37.4	(2.4)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[a]	85	35.1	(4.4)	32.0	(5.1)	21.3	(4.1)	6.3	(2.1)	5.3	(2.6)
	Chile[†b]	653	4.7	(0.8)	19.9	(1.1)	43.3	(2.1)	20.7	(1.7)	11.4	(1.4)
	Norway (ALU)[†c]	392	2.4	(0.9)	4.7	(1.0)	18.5	(1.8)	21.5	(2.5)	52.9	(2.7)
	Norway (ALU+)[†c]	158	1.2	(0.0)	6.4	(2.3)	24.6	(3.7)	14.7	(2.7)	53.1	(4.0)
Primary Mathematics Specialists	Germany[†]	80	0.3	(0.3)	4.5	(2.5)	14.1	(6.3)	32.9	(8.5)	48.2	(9.7)
	Malaysia	567	9.9	(1.1)	27.6	(1.8)	39.8	(2.1)	11.7	(1.3)	10.9	(1.5)
	Poland[†d]	300	3.0	(1.1)	9.5	(1.6)	40.3	(3.6)	24.0	(2.0)	23.3	(3.2)
	Singapore	117	3.5	(1.7)	14.4	(3.1)	36.7	(4.9)	22.4	(3.5)	23.0	(4.0)
	Thailand[†]	659	13.9	(1.4)	27.9	(1.5)	37.0	(2.0)	12.0	(1.3)	9.2	(1.2)
	United States[†g]	150	1.9	(1.5)	5.5	(1.8)	29.5	(5.8)	18.8	(2.4)	44.3	(5.6)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.16: Future lower-secondary teachers' estimates of the number of books in their parents' or guardians' homes (estimated percent)

Program-Group	Country		Percent of Future Primary Teachers in Response Categories (weighted estimates)									
			None or Few		*Enough to Fill One Bookshelf*		*Enough to Fill One Bookcase*		*Enough to Fill Two Bookcases*		*Enough to Fill Three or More Book Cases*	
		n	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)
Lower Secondary (to Grade 11 Maximum)	Botswana[a]	33	45.4	(9.2)	33.2	(6.3)	21.3	(8.0)	0.0	(0.0)	0.0	(0.0)
	Chile[†b]	745	6.2	(0.9)	20.7	(1.5)	44.6	(1.9)	16.9	(1.3)	11.6	(1.0)
	Germany[†]	346	3.6	(2.7)	9.8	(3.8)	21.6	(5.7)	18.3	(2.5)	46.7	(5.6)
	Norway (ALU)[†d]	355	1.4	(0.7)	6.4	(1.3)	17.9	(1.8)	25.8	(2.7)	48.4	(2.5)
	Norway (ALU+)[†d]	148	0.6	(0.6)	5.9	(2.1)	30.5	(3.9)	23.0	(4.0)	40.1	(4.4)
	Philippines	731	37.1	(4.2)	39.7	(4.4)	20.4	(3.0)	1.9	(0.5)	0.9	(0.4)
	Poland[†e]	158	3.4	(1.5)	12.8	(2.6)	38.4	(4.0)	26.8	(3.8)	18.6	(3.9)
	Singapore	141	5.9	(2.3)	19.3	(3.2)	29.7	(3.3)	24.4	(4.0)	20.8	(3.0)
	Switzerland[g]	141	2.7	(1.4)	5.4	(2.1)	26.0	(3.6)	22.4	(3.3)	43.4	(4.1)
	United States[†h]	131	0.0	(0.0)	5.5	(1.1)	23.0	(4.1)	31.2	(4.6)	40.3	(7.2)
Lower and Upper Secondary (to Grade 11 and above)	Botswana[†h]	19	31.6	(7.4)	31.6	(11.2)	26.3	(8.3)	10.5	(7.4)	0.0	(0.0)
	Chinese Taipei	364	12.1	(1.8)	18.7	(2.0)	30.6	(3.2)	17.0	(2.0)	21.6	(2.3)
	Georgia[c]	75	0.0	(0.0)	11.8	(3.2)	35.0	(6.4)	18.5	(4.7)	34.6	(5.1)
	Germany	303	1.1	(0.5)	4.8	(1.6)	18.7	(2.9)	16.5	(2.7)	59.0	(3.2)
	Malaysia	387	18.9	(2.0)	24.4	(3.0)	39.1	(2.4)	8.9	(1.6)	8.7	(1.6)
	Norway (PPU & Master's)[d]	65	0.0	(0.0)	4.2	(2.7)	14.7	(4.8)	21.8	(3.0)	59.3	(5.4)
	Oman	267	14.4	(2.0)	26.9	(2.5)	39.3	(2.7)	11.7	(1.8)	7.7	(1.3)
	Poland[e]	140	0.8	(0.6)	9.1	(2.5)	39.4	(5.4)	23.0	(4.3)	27.7	(5.9)
	Russian Federation[f]	2,138	1.4	(0.4)	8.8	(0.7)	37.4	(1.2)	31.3	(1.3)	21.1	(1.6)
	Singapore	251	6.8	(1.3)	17.9	(2.3)	37.8	(2.3)	18.3	(2.1)	19.1	(2.8)
	Thailand[†]	651	16.5	(1.2)	26.4	(1.9)	36.2	(1.9)	12.0	(1.4)	8.9	(1.1)
	United States[h]	371	6.5	(1.3)	11.0	(1.9)	27.8	(2.5)	22.5	(3.4)	32.2	(3.9)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit 4.17: Future primary teachers' reports of the educational resources they have at home (estimated percent)

Program-Group	Country	Percent of Future Primary Teachers in Response Categories (Weighted Estimates)																							
		Calculator			*Computer*			*Study Desk*			*Dictionary*			*Encyclopedia*			*Play Station*			*DVD Player*			*Three or More Cars*		
		n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Lower Primary (to Grade 4 Maximum)	Georgia	492	85.1	(1.5)	488	26.0	(2.2)	491	85.7	(1.4)	486	78.1	(2.0)	467	46.0	(2.1)	472	13.5	(1.2)	474	48.5	(3.0)	487	16.1	(1.3)
	Germany	825	99.3	(0.4)	825	94.4	(1.2)	825	96.5	(0.9)	825	97.6	(0.7)	819	91.4	(1.4)	811	24.7	(2.6)	820	80.9	(1.8)	818	26.1	(1.8)
	Poland[d]	1,804	98.4	(0.4)	1,803	94.3	(0.7)	1,803	93.8	(0.9)	1,803	98.2	(0.5)	1,804	93.9	(1.1)	1,738	13.9	(0.9)	1,798	83.4	(1.2)	1,793	12.2	(1.0)
	Russian Federation[e]	2,250	97.9	(0.4)	2,252	77.5	(2.1)	2,244	91.4	(1.2)	2,251	94.5	(0.8)	2,235	86.1	(1.8)	2,185	20.6	(1.4)	2,242	86.9	(1.0)	2,246	14.6	(1.0)
	Switzerland[f]	121	98.2	(0.2)	121	98.2	(1.3)	121	98.4	(1.6)	121	99.2	(0.8)	120	80.4	(3.3)	120	38.9	(4.0)	121	86.2	(3.0)	120	14.1	(3.2)
Primary (to Grade 6 Maximum)	Chinese Taipei	923	99.8	(0.2)	923	99.1	(0.3)	922	96.5	(0.6)	923	98.9	(0.3)	915	54.4	(2.1)	916	34.9	(1.5)	923	84.1	(1.2)	922	23.8	(1.5)
	Philippines	590	98.6	(0.6)	585	37.5	(3.0)	587	85.9	(1.6)	588	97.7	(0.5)	584	37.2	(2.4)	583	35.2	(1.9)	589	66.6	(7.7)	586	10.9	(2.5)
	Singapore	263	100.0	(0.0)	263	98.5	(0.8)	263	96.2	(1.1)	263	98.5	(0.8)	263	73.4	(2.2)	262	51.0	(3.7)	263	93.9	(1.4)	263	14.8	(2.7)
	Spain	1,091	99.4	(0.2)	1,091	98.4	(0.4)	1,090	97.7	(0.5)	1,089	99.1	(0.3)	1,083	97.4	(0.6)	1,068	56.2	(1.8)	1,090	94.7	(0.7)	1,091	36.1	(2.3)
	Switzerland[f]	812	99.7	(0.3)	812	98.2	(0.6)	812	98.8	(0.5)	812	98.3	(0.4)	811	79.5	(1.3)	810	35.9	(1.6)	812	85.9	(1.3)	810	14.6	(1.2)
	United States[g]	1,037	98.7	(0.6)	1,036	96.8	(0.8)	1,037	93.4	(0.8)	1,037	97.2	(0.6)	1,032	82.8	(1.8)	1,034	62.3	(2.2)	1,036	97.6	(0.6)	1,035	66.7	(2.5)
Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[a]	85	89.3	(3.8)	86	38.0	(4.8)	84	70.7	(4.8)	85	73.4	(4.2)	84	21.0	(3.7)	84	36.8	(5.6)	84	75.5	(4.5)	85	19.7	(3.6)
	Chile[†b]	654	99.7	(0.2)	655	96.4	(0.9)	653	93.0	(1.1)	654	98.8	(0.4)	651	93.5	(1.0)	641	38.7	(2.0)	654	89.8	(1.0)	654	8.3	(1.3)
	Norway (ALU)[†c]	392	100.0	(0.0)	392	95.5	(0.9)	392	95.1	(1.2)	389	95.4	(0.9)	390	94.1	(1.5)	386	51.8	(2.6)	392	94.1	(1.3)	391	20.9	(2.4)
	Norway (ALU+)[†c]	159	98.3	(0.9)	159	93.8	(1.6)	159	92.2	(2.2)	159	93.9	(1.6)	157	91.0	(2.4)	159	52.3	(3.3)	159	88.4	(3.1)	159	13.6	(2.4)
Primary Mathematics Specialists	Germany[†]	80	100.0	(0.0)	80	92.5	(5.4)	80	99.7	(0.3)	80	98.2	(1.8)	78	86.5	(6.3)	78	32.5	(9.2)	80	76.7	(9.3)	79	8.2	(3.5)
	Malaysia	574	99.7	(0.2)	574	94.0	(1.1)	574	92.5	(1.3)	574	99.3	(0.2)	569	53.9	(2.0)	571	42.1	(2.1)	573	79.4	(2.0)	573	31.6	(2.0)
	Poland[†d]	300	99.4	(0.4)	300	98.3	(0.8)	299	96.1	(1.2)	300	98.9	(0.5)	300	97.4	(0.9)	297	8.2	(1.8)	300	76.3	(3.2)	300	13.4	(2.7)
	Singapore	117	98.3	(1.2)	117	98.4	(1.2)	117	96.4	(1.8)	116	99.2	(0.8)	115	72.5	(3.6)	117	58.2	(5.5)	117	96.6	(1.7)	117	14.7	(3.9)
	Thailand[†]	660	94.4	(0.9)	659	75.9	(1.6)	657	84.2	(1.3)	659	83.1	(1.5)	651	21.0	(1.6)	657	44.5	(2.3)	657	78.5	(1.5)	658	44.6	(1.9)
	United States[†g]	150	95.4	(3.5)	150	94.1	(2.9)	150	93.4	(1.5)	150	94.3	(1.7)	149	75.7	(3.0)	150	70.9	(5.9)	150	95.6	(3.3)	150	63.3	(8.0)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.18: Future lower-secondary teachers' reports of the educational resources they have at home (estimated percent)

Program-Group	Country	Percent of Future Lower-Secondary Teachers in Response Categories (weighted estimates)																							
		Calculator			*Computer*			*Study Desk*			*Dictionary*			*Encyclopedia*			*Play Station*			*DVD Player*			*Three or More Cars*		
		n	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*	*n*	Est.	*(SE)*
Lower Secondary (to Grade 10 Maximum)	Botswana[a]	33	94.0	(4.3)	33	30.0	(7.4)	33	88.2	(4.2)	32	84.4	(7.0)	32	6.1	(4.3)	33	39.3	(11.0)	33	78.8	(8.0)	32	15.3	(5.4)
	Chile[†b]	708	98.9	(0.4)	708	94.8	(0.8)	705	92.1	(0.9)	706	99.3	(0.3)	705	94.5	(0.8)	691	36.9	(2.2)	709	90.7	(1.1)	700	10.5	(1.2)
	Germany[†]	342	97.4	(2.6)	342	83.9	(4.9)	342	94.7	(2.9)	342	95.3	(2.9)	338	84.7	(4.5)	333	25.8	(3.1)	340	69.6	(4.9)	337	17.4	(2.1)
	Norway (ALU)[†d]	355	99.4	(0.4)	354	96.5	(0.7)	355	93.0	(1.3)	355	95.1	(1.0)	352	94.0	(1.2)	352	51.6	(2.8)	355	96.5	(0.9)	355	21.5	(2.1)
	Norway (ALU+)[†d]	150	95.4	(1.0)	150	89.1	(1.8)	150	87.9	(2.8)	150	94.3	(1.9)	149	94.3	(2.0)	150	46.7	(4.7)	149	83.5	(2.4)	149	17.8	(3.2)
	Philippines	732	97.2	(1.0)	726	32.4	(1.8)	729	78.8	(2.9)	730	94.6	(1.4)	724	38.8	(3.3)	724	25.4	(2.2)	727	62.2	(3.8)	727	5.3	(0.9)
	Poland[†e]	158	100.0	(0.0)	158	97.7	(1.3)	158	95.8	(1.7)	158	99.2	(0.8)	157	92.3	(2.3)	154	8.5	(1.8)	158	77.1	(3.5)	158	12.3	(2.5)
	Singapore	141	100.0	(0.0)	141	98.5	(1.0)	141	94.3	(1.8)	141	98.5	(1.0)	138	62.9	(3.7)	141	43.5	(3.9)	141	94.3	(2.5)	141	9.8	(2.4)
	Switzerland[g]	141	100.0	(0.0)	141	96.9	(1.6)	141	98.3	(1.2)	141	98.3	(1.2)	141	83.9	(2.9)	140	39.5	(5.2)	141	85.5	(3.0)	141	16.1	(2.8)
	United States[†h]	130	100.0	(0.0)	130	97.8	(0.8)	130	95.3	(1.2)	130	99.7	(0.4)	130	81.6	(2.7)	130	58.0	(2.2)	130	98.3	(0.8)	130	67.6	(1.6)
Lower and Upper Secondary (to Grade 11 and above)	Botswana[†h]	19	94.7	(5.3)	19	42.1	(11.2)	19	78.9	(9.8)	19	94.7	(5.3)	19	21.1	(9.8)	19	42.1	(6.4)	19	89.5	(6.4)	19	10.5	(6.4)
	Chinese Taipei[c]	365	98.9	(0.5)	365	96.2	(0.9)	365	95.2	(1.0)	365	97.6	(0.8)	363	46.1	(2.2)	364	40.4	(2.7)	365	78.4	(2.2)	365	17.7	(2.3)
	Georgia[c]	77	90.8	(4.5)	77	32.1	(5.2)	78	89.7	(2.7)	78	85.2	(3.8)	77	50.3	(5.1)	76	15.5	(3.8)	77	35.0	(4.6)	76	12.2	(3.9)
	Germany	298	99.4	(0.4)	299	92.1	(2.4)	299	93.0	(2.0)	299	95.3	(1.8)	297	89.0	(2.3)	295	21.3	(2.6)	298	71.5	(3.6)	297	15.7	(2.7)
	Malaysia	388	99.6	(0.3)	388	87.1	(1.8)	388	87.1	(2.0)	388	98.5	(0.7)	385	42.6	(2.6)	388	44.7	(2.5)	388	77.3	(2.3)	385	31.1	(2.1)
	Norway (PPU & Master's)[d]	64	96.4	(2.6)	64	88.4	(4.4)	64	89.4	(3.5)	64	94.9	(2.5)	64	92.2	(3.1)	64	29.3	(6.8)	64	83.1	(4.4)	64	20.6	(4.7)
	Oman	268	99.6	(0.4)	267	93.9	(1.8)	266	68.2	(2.6)	267	88.9	(1.7)	264	60.6	(2.9)	263	68.7	(2.4)	267	49.7	(3.1)	266	53.7	(2.5)
	Poland[e]	140	100.0	(0.0)	140	96.0	(2.4)	140	97.8	(1.1)	140	100.0	(0.0)	140	92.3	(3.3)	137	9.9	(1.9)	140	63.6	(3.9)	140	11.9	(5.0)
	Russian Federation[f]	2,135	98.0	(0.7)	2,134	89.5	(1.1)	2,134	90.6	(1.1)	2,131	92.8	(0.9)	2,133	85.9	(1.3)	2,098	16.4	(1.5)	2,132	77.7	(1.3)	2,128	12.8	(1.2)
	Singapore	250	99.2	(0.6)	250	98.0	(0.9)	250	95.2	(1.3)	250	96.4	(1.1)	250	59.6	(2.8)	249	45.4	(3.1)	250	91.6	(1.6)	250	12.4	(2.3)
	Thailand[†]	650	95.0	(0.9)	649	75.3	(1.5)	650	80.3	(1.4)	651	80.8	(1.5)	647	19.9	(1.4)	651	43.8	(1.6)	650	81.3	(1.2)	649	47.1	(2.0)
	United States[h]	371	98.4	(0.7)	371	96.5	(1.3)	371	90.5	(1.7)	371	96.5	(1.0)	370	77.2	(2.2)	371	64.6	(3.1)	371	97.3	(0.8)	371	61.3	(4.6)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.19: Future primary teachers' reports of the highest level of education completed by their mothers, stepmothers, or female guardians (estimated percent)

Program-Group	Country		Percent of Future Primary Teachers in Response Categories (weighted estimates)															
			Primary		*Lower Secondary*		*Upper Secondary*		*Post-Secondary Non-Tertiary*		*Practical or Vocational Training*		*First Degree*		*Beyond ISCED 5A*		*Don't Know*	
		n	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	472	1.7	(0.6)	0.2	(0.2)	14.3	(1.5)	28.3	(2.8)	39.0	(2.7)	8.9	(1.0)	4.8	(1.2)	2.7	(0.8)
	Germany	917	4.1	(1.0)	19.3	(1.7)	5.9	(1.2)	37.7	(2.2)	6.6	(1.1)	10.1	(1.4)	14.7	(1.7)	1.6	(0.6)
	Poland[d]	1,623	0.0	(0.0)	9.1	(0.9)	75.3	(1.4)	0.0	(0.0)	0.0	(0.0)	4.1	(0.4)	11.0	(0.9)	0.5	(0.2)
	Russian Federation[e]	2,241	0.4	(0.2)	3.4	(0.6)	7.8	(0.9)	15.2	(0.8)	45.5	(1.4)	6.2	(0.9)	20.8	(1.3)	0.7	(0.2)
	Switzerland[f]	120	2.3	(1.3)	17.5	(3.1)	39.9	(5.1)	10.7	(3.2)	7.9	(2.4)	12.9	(3.4)	4.5	(2.0)	4.2	(1.9)
Primary (to Grade 6 Maximum)	Chinese Taipei	923	19.9	(1.1)	18.9	(1.0)	37.8	(1.6)	10.9	(1.0)	0.0	(0.0)	10.3	(1.1)	1.8	(0.5)	0.6	(0.3)
	Philippines	584	26.7	(2.9)	9.9	(1.5)	21.4	(2.3)	13.2	(2.3)	8.9	(1.6)	15.9	(2.2)	2.4	(0.9)	1.7	(0.5)
	Singapore	263	26.6	(2.5)	12.2	(2.1)	39.1	(2.5)	11.8	(2.0)	3.4	(1.3)	2.6	(0.8)	0.8	(0.6)	3.4	(1.3)
	Spain	1,077	37.6	(2.8)	16.7	(1.3)	15.2	(2.1)	0.0	(0.0)	15.6	(1.3)	8.4	(1.0)	4.6	(1.0)	2.0	(0.5)
	Switzerland[f]	810	4.0	(0.9)	21.3	(1.7)	35.9	(1.6)	5.9	(0.8)	10.0	(1.0)	15.6	(1.4)	6.2	(0.9)	1.1	(0.4)
	United States[g]	1,300	1.5	(0.5)	2.6	(0.5)	34.5	(1.9)	9.9	(1.0)	14.3	(1.1)	21.7	(1.5)	14.7	(1.0)	0.8	(0.3)
Primary and Secondary Generalists (to Grade 6 Maximum)	Botswana[a]	85	47.9	(6.0)	12.4	(3.2)	6.9	(2.8)	9.4	(3.2)	2.4	(1.7)	3.5	(1.9)	4.6	(2.3)	12.9	(4.3)
	Chile[†b]	650	13.4	(1.1)	12.4	(1.7)	40.7	(2.1)	8.2	(1.1)	10.7	(1.3)	10.2	(1.0)	3.8	(0.7)	0.6	(0.3)
	Norway (ALU)[†c]	390	1.6	(0.7)	8.3	(1.3)	14.7	(1.6)	15.6	(1.7)	14.9	(1.5)	14.7	(2.0)	25.3	(2.2)	4.9	(1.1)
	Norway (ALU+)[†c]	158	2.3	(1.1)	14.4	(2.7)	18.9	(2.6)	10.7	(2.1)	17.0	(2.6)	12.1	(2.9)	18.8	(2.6)	6.0	(1.8)
Primary Mathematics Specialists	Germany[†]	95	4.7	(4.3)	25.6	(7.2)	3.1	(2.1)	42.5	(8.4)	1.9	(1.5)	2.6	(1.5)	18.9	(6.6)	0.8	(0.4)
	Malaysia	575	34.7	(1.8)	15.5	(1.4)	29.4	(2.0)	4.1	(0.9)	7.1	(1.1)	4.3	(0.8)	0.9	(0.4)	4.1	(0.8)
	Poland[†d]	272	0.0	(0.0)	4.8	(1.1)	70.9	(3.7)	0.0	(0.0)	0.0	(0.0)	3.6	(1.3)	18.8	(4.0)	1.9	(0.9)
	Singapore	116	27.6	(4.1)	13.7	(3.5)	34.2	(3.8)	9.9	(3.0)	2.7	(1.5)	7.0	(2.8)	0.0	(0.0)	4.9	(2.0)
	Thailand[†]	659	62.4	(1.8)	7.6	(1.0)	5.2	(0.9)	4.6	(0.7)	1.4	(0.5)	15.5	(1.3)	1.5	(0.4)	1.8	(0.5)
	United States[†g]	189	1.2	(1.4)	1.1	(0.7)	43.4	(4.0)	8.3	(2.9)	17.5	(5.7)	16.8	(3.4)	11.7	(3.4)	0.0	(0.0)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.20: Future lower-secondary teachers' reports of the highest level of education completed by their mothers, stepmothers, or female guardians (estimated percent)

Program-Group	Country		Percent of Future Lower-Secondary Teachers in Response Categories (weighted estimates)															
			Primary		*Lower Secondary*		*Upper Secondary*		*Post-Secondary Non-Tertiary*		*Practical or Vocational Training*		*First Degree*		*Beyond ISCED 5A*		*Don't Know*	
		n	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)
Lower Secondary (to Grade 10 Maximum)	Botswana[a]	34	55.9	(7.8)	26.4	(6.6)	8.9	(5.1)	5.9	(4.1)	0.0	(0.0)	3.0	(3.0)	0.0	(0.0)	0.0	(0.0)
	Chile†[b]	709	12.3	(1.4)	12.4	(1.4)	39.2	(1.8)	11.1	(1.3)	10.9	(1.2)	9.2	(1.0)	4.0	(0.8)	1.0	(0.4)
	Germany†	397	6.9	(2.6)	35.3	(5.4)	4.9	(1.6)	30.6	(4.6)	3.7	(1.3)	6.9	(2.9)	10.5	(2.4)	1.2	(0.8)
	Norway (ALU)†[d]	352	0.9	(0.5)	7.9	(1.6)	15.1	(1.8)	16.6	(2.2)	18.5	(1.9)	12.8	(1.6)	24.6	(2.0)	3.7	(0.9)
	Norway (ALU+)†[d]	149	3.3	(1.6)	11.4	(3.0)	18.3	(3.2)	14.9	(3.4)	18.1	(2.5)	10.4	(2.9)	21.7	(4.2)	1.9	(1.1)
	Philippines	726	22.1	(3.0)	9.7	(1.2)	24.9	(2.5)	12.9	(1.2)	6.8	(1.1)	20.0	(1.6)	2.1	(0.5)	1.4	(0.6)
	Poland†[e]	136	0.0	(0.0)	5.6	(1.7)	69.5	(4.4)	0.0	(0.0)	0.0	(0.0)	6.5	(3.6)	17.5	(4.1)	0.8	(0.8)
	Singapore	141	30.3	(4.1)	8.0	(1.9)	34.3	(3.1)	12.2	(3.7)	3.7	(1.7)	5.0	(1.8)	1.3	(0.9)	5.0	(1.2)
	Switzerland[g]	139	5.2	(1.7)	29.9	(3.9)	32.7	(3.7)	3.1	(1.4)	7.1	(2.2)	15.8	(3.2)	6.1	(2.2)	0.0	(0.0)
	United States†[h]	169	0.4	(0.3)	0.2	(0.2)	32.7	(4.9)	4.2	(1.8)	28.6	(3.3)	22.9	(3.8)	10.5	(1.0)	0.5	(0.4)
Lower and Upper Secondary (to Grade 11 and above)	Botswana†[h]	18	61.1	(12.0)	5.6	(5.6)	11.1	(7.9)	5.6	(5.6)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	16.7	(8.8)
	Chinese Taipei	365	24.2	(2.0)	16.7	(2.2)	39.6	(2.4)	8.9	(1.2)	0.0	(0.0)	6.7	(1.4)	2.3	(1.0)	1.6	(0.5)
	Georgia[c]	74	1.2	(1.7)	0.0	(0.0)	17.5	(3.9)	20.6	(5.2)	25.8	(5.5)	20.9	(5.4)	12.9	(5.4)	1.2	(1.2)
	Germany	359	6.7	(2.1)	19.6	(2.0)	3.7	(1.3)	29.9	(2.6)	5.3	(1.5)	11.7	(2.0)	21.3	(2.6)	1.8	(1.1)
	Malaysia	388	25.9	(1.7)	16.0	(1.9)	36.3	(2.3)	7.0	(1.3)	6.7	(1.2)	3.7	(0.8)	1.2	(0.5)	3.2	(0.9)
	Norway (PPU & Master's)[d]	65	1.6	(1.6)	11.9	(4.4)	17.1	(4.3)	6.3	(2.9)	10.4	(3.6)	24.3	(5.3)	27.2	(4.7)	1.1	(1.1)
	Oman	259	51.3	(3.0)	9.0	(1.9)	6.9	(1.9)	0.0	(0.0)	1.8	(0.8)	1.1	(0.7)	0.0	(0.0)	29.9	(3.4)
	Poland[e]	127	0.0	(0.0)	3.7	(1.6)	69.2	(4.1)	0.0	(0.0)	0.0	(0.0)	6.5	(3.0)	20.1	(3.8)	0.5	(0.5)
	Russian Federation[f]	2,119	0.1	(0.1)	1.8	(0.3)	6.7	(1.3)	12.5	(0.6)	42.4	(1.7)	4.5	(0.6)	30.7	(1.4)	1.1	(0.2)
	Singapore	249	33.7	(2.2)	9.7	(1.8)	32.1	(2.3)	13.2	(1.9)	4.8	(1.5)	4.0	(1.3)	1.2	(0.7)	1.2	(0.7)
	Thailand†	652	63.8	(2.0)	7.1	(1.2)	4.3	(0.6)	3.8	(0.7)	2.0	(0.5)	14.4	(1.0)	2.9	(0.6)	1.7	(0.5)
	United States[h]	430	1.3	(0.7)	2.1	(0.8)	35.4	(2.8)	5.7	(1.2)	17.6	(2.1)	20.5	(2.3)	17.1	(2.0)	0.3	(0.2)

Notes:
1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.21: Future primary teachers' reports on the highest level of education completed by their fathers, stepfathers, or male guardians (estimated percent)

Program-Group	Country		Percent of Future Primary Teachers in Response Categories (weighted estimates)															
			Primary		*Lower Secondary*		*Upper Secondary*		*Post-Secondary Non-Tertiary*		*Practical or Vocational Training*		*First Degree*		*Beyond ISCED 5A*		*Don't Know*	
		n	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	476	0.2	(0.2)	0.8	(0.4)	17.9	(1.5)	32.3	(2.1)	35.8	(2.1)	6.1	(0.7)	4.0	(1.0)	2.9	(0.8)
	Germany	916	2.9	(0.9)	15.9	(1.6)	3.4	(0.8)	27.2	(1.8)	11.0	(1.5)	17.2	(1.8)	19.2	(2.1)	3.3	(1.0)
	Poland[d]	1,729	0.0	(0.0)	7.8	(0.9)	81.9	(1.4)	0.0	(0.0)	0.0	(0.0)	3.3	(0.4)	5.5	(0.9)	1.5	(0.3)
	Russian Federation[e]	2,220	0.5	(0.2)	4.2	(0.5)	7.2	(1.0)	19.6	(1.4)	42.6	(1.6)	5.0	(0.8)	17.0	(1.5)	4.0	(0.6)
	Switzerland[f]	119	2.8	(1.7)	14.8	(3.0)	34.1	(4.7)	1.0	(1.0)	21.4	(5.0)	7.9	(2.7)	14.6	(3.3)	3.3	(1.9)
Primary (to Grade 6 Maximum)	Chinese Taipei	923	11.5	(1.0)	14.7	(1.0)	36.8	(1.5)	15.3	(1.2)	0.0	(0.0)	16.5	(1.0)	4.8	(0.6)	0.4	(0.2)
	Philippines	581	25.5	(3.0)	8.1	(0.8)	24.1	(2.8)	10.9	(2.3)	14.5	(1.2)	12.5	(1.6)	2.0	(0.8)	2.4	(0.9)
	Singapore	262	19.6	(2.4)	13.3	(2.2)	28.6	(2.5)	13.3	(1.9)	11.0	(1.7)	8.9	(1.9)	2.3	(0.9)	3.1	(1.2)
	Spain	1,087	35.9	(2.4)	15.1	(0.8)	14.7	(1.3)	0.0	(0.0)	15.4	(1.4)	6.1	(1.0)	9.6	(1.1)	3.3	(0.5)
	Switzerland[f]	811	3.0	(0.6)	12.9	(1.2)	31.4	(1.7)	0.6	(0.3)	20.7	(1.3)	9.6	(1.0)	20.1	(1.6)	1.7	(0.5)
	United States[g]	1,302	1.4	(0.3)	3.0	(0.6)	32.2	(2.0)	11.6	(1.1)	10.1	(0.9)	22.3	(1.7)	16.7	(2.4)	2.6	(0.4)
Primary and Secondary Generalists (to Grade 6 Maximum)	Botswana[a]	83	28.8	(7.0)	13.5	(3.8)	4.5	(1.7)	5.1	(2.5)	4.4	(2.2)	3.7	(2.1)	2.4	(1.5)	37.6	(5.9)
	Chile[†b]	650	10.4	(1.3)	11.8	(1.6)	35.7	(1.9)	11.2	(1.1)	12.0	(1.3)	10.0	(1.0)	4.3	(0.9)	4.6	(0.7)
	Norway (ALU)[†c]	390	1.3	(0.5)	9.1	(1.6)	8.2	(1.6)	6.9	(1.4)	30.4	(2.6)	12.0	(1.6)	28.2	(2.1)	4.0	(1.0)
	Norway (ALU+)[†c]	159	0.6	(0.6)	13.9	(2.7)	8.7	(2.1)	10.2	(2.1)	30.6	(3.1)	8.2	(2.2)	23.1	(2.5)	4.7	(1.5)
Primary Mathematics Specialists	Germany[†]	94	4.5	(4.3)	19.1	(6.7)	3.9	(2.1)	28.6	(9.3)	11.0	(5.1)	14.7	(5.4)	14.5	(5.2)	3.6	(1.9)
	Malaysia	576	29.3	(1.8)	14.4	(1.5)	28.5	(2.2)	6.9	(1.2)	9.2	(1.1)	7.5	(1.0)	1.5	(0.5)	2.6	(0.6)
	Poland[†d]	286	0.0	(0.0)	9.3	(1.8)	74.8	(2.7)	0.0	(0.0)	0.0	(0.0)	4.4	(1.2)	8.9	(2.3)	2.6	(1.0)
	Singapore	117	25.5	(4.4)	8.6	(2.7)	31.3	(3.8)	12.2	(2.5)	4.4	(0.8)	10.6	(3.0)	2.4	(1.4)	5.0	(1.6)
	Thailand[†]	659	48.6	(1.9)	9.0	(1.2)	9.8	(1.4)	6.0	(0.9)	1.5	(0.4)	18.2	(1.3)	5.0	(0.9)	2.0	(0.6)
	United States[†g]	190	2.2	(1.2)	0.2	(0.2)	33.7	(6.6)	9.8	(2.6)	16.9	(1.6)	17.6	(2.0)	19.8	(4.7)	0.0	(0.0)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.22: Future lower-secondary teachers' reports on the highest level of education completed by their fathers, stepfathers, or male guardians (estimated percent)

Program-Group	Country		Percent of Future Lower-Secondary Teachers in Response Categories (weighted estimates)															
			Primary		*Lower Secondary*		*Upper Secondary*		*Post-Secondary Non-Tertiary*		*Practical or Vocational Training*		*First Degree*		*Beyond ISCED 5A*		*Don't Know*	
		n	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)	Est.	(*SE*)
Lower Secondary (to Grade 10 Maximum)	Botswana[a]	34	38.3	(6.6)	20.6	(5.1)	8.9	(5.1)	3.0	(3.0)	8.9	(5.1)	3.0	(3.0)	2.9	(2.9)	14.6	(6.5)
	Chile[†b]	740	11.4	(1.3)	11.4	(1.3)	36.5	(1.4)	11.5	(0.9)	8.7	(1.1)	11.7	(1.2)	4.8	(0.8)	4.0	(0.7)
	Germany[†]	395	7.7	(3.3)	23.3	(3.6)	2.0	(0.6)	19.2	(4.2)	12.9	(3.5)	13.4	(2.5)	19.4	(3.6)	2.0	(0.9)
	Norway (ALU)[†d]	354	1.1	(0.4)	8.5	(1.5)	9.7	(1.9)	9.5	(1.4)	26.3	(2.1)	11.4	(1.6)	30.5	(2.5)	3.1	(1.0)
	Norway (ALU+)[†d]	149	5.2	(1.6)	9.0	(2.5)	13.3	(2.9)	4.3	(1.7)	26.2	(3.6)	6.8	(1.6)	32.8	(4.3)	2.5	(1.2)
	Philippines	728	22.9	(2.9)	6.4	(1.0)	25.5	(4.0)	11.3	(1.0)	14.8	(1.8)	15.1	(1.7)	2.2	(0.6)	1.7	(0.7)
	Poland[†e]	153	0.0	(0.0)	3.6	(1.1)	83.1	(4.0)	0.0	(0.0)	0.0	(0.0)	3.7	(1.6)	7.1	(2.7)	2.6	(1.5)
	Singapore	141	19.7	(2.8)	18.1	(3.0)	31.1	(3.4)	9.9	(2.5)	6.5	(2.2)	7.2	(1.7)	2.1	(1.2)	5.3	(1.8)
	Switzerland[g]	141	5.4	(1.7)	18.7	(2.4)	23.6	(3.3)	0.9	(0.7)	22.2	(3.3)	9.8	(2.8)	18.8	(2.9)	0.6	(0.6)
	United States[†h]	169	0.8	(0.6)	0.2	(0.3)	30.4	(3.7)	4.4	(2.2)	13.1	(2.2)	28.9	(3.8)	21.0	(3.7)	1.3	(0.9)
Lower and Upper Secondary (to Grade 11 and above)	Botswana[†h]	17	47.1	(13.3)	11.8	(8.4)	5.9	(5.9)	0.0	(0.0)	0.0	(0.0)	0.0	(0.0)	5.9	(5.9)	29.4	(9.6)
	Chinese Taipei	365	16.3	(2.3)	16.6	(1.7)	31.2	(3.0)	17.2	(2.1)	0.0	(0.0)	14.2	(2.0)	3.6	(0.9)	0.8	(0.5)
	Georgia[c]	75	0.0	(0.0)	0.0	(0.0)	16.4	(3.8)	24.7	(5.0)	23.6	(5.1)	24.3	(5.1)	9.9	(3.4)	1.2	(1.2)
	Germany	357	3.3	(1.5)	13.0	(2.5)	3.3	(1.2)	19.4	(2.9)	9.2	(1.9)	21.3	(2.6)	28.8	(1.8)	1.6	(1.0)
	Malaysia	386	19.0	(2.1)	15.3	(2.1)	36.7	(3.3)	5.7	(1.1)	8.9	(1.3)	6.4	(1.3)	3.6	(0.9)	4.4	(0.9)
	Norway (PPU & Master's)[d]	65	4.6	(2.5)	6.0	(3.1)	10.7	(4.0)	8.7	(4.8)	23.9	(5.1)	18.3	(4.3)	27.8	(6.0)	0.0	(0.0)
	Oman	260	34.1	(3.4)	17.0	(2.9)	12.7	(2.1)	2.4	(1.0)	5.1	(1.3)	3.9	(1.5)	2.4	(0.8)	22.2	(2.7)
	Poland[e]	137	0.0	(0.0)	7.9	(2.0)	73.4	(4.0)	0.0	(0.0)	0.0	(0.0)	6.4	(2.6)	9.8	(3.1)	2.6	(1.5)
	Russian Federation[f]	2,112	0.3	(0.2)	2.7	(0.5)	8.3	(1.2)	17.6	(1.2)	39.9	(1.6)	3.9	(0.4)	21.5	(1.1)	5.9	(0.7)
	Singapore	250	24.0	(2.2)	15.2	(2.3)	28.4	(2.9)	13.6	(1.9)	6.4	(1.4)	5.6	(1.6)	4.4	(1.2)	2.4	(1.1)
	Thailand[†]	652	52.9	(2.1)	8.4	(1.0)	8.8	(1.3)	3.6	(0.7)	0.9	(0.4)	17.8	(1.6)	5.5	(0.8)	2.1	(0.5)
	United States[h]	430	1.1	(0.7)	2.9	(1.1)	27.0	(2.4)	9.4	(1.7)	10.8	(1.3)	23.6	(2.4)	24.8	(3.1)	0.5	(0.3)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.23: Future primary teachers selecting significant or major reasons for becoming a teacher (estimated percent)

Program-Group	Country	Percent of Future Lower-Secondary Teachers in Response Categories (weighted estimates)																										
		Good Student			*Available Positions*			*Love Mathematics*			*Talent Teaching*			*Like Working with Young People*			*Teacher Salaries*			*Next Generation*			*Challenging Job*			*Long-Term Security*		
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Primary (to Grade 4 Maximum)	Georgia	231	37.6	(4.0)	205	36.4	(3.7)	202	42.6	(3.2)	206	48.1	(3.8)	219	60.1	(3.3)	191	28.3	(3.5)	200	53.0	(3.5)	241	64.7	(3.9)	206	56.9	(2.9)
	Germany	875	34.8	(2.3)	871	24.0	(2.0)	866	32.8	(2.0)	870	89.1	(1.6)	868	94.3	(1.1)	871	35.2	(2.3)	870	75.4	(1.8)	873	90.9	(1.2)	873	54.2	(1.9)
	Poland[d]	1,740	15.5	(0.9)	1,733	8.0	(0.7)	1,717	5.1	(0.9)	1,721	53.4	(1.5)	1,737	79.9	(1.1)	1,704	3.5	(0.5)	1,718	46.7	(1.8)	1,717	54.9	(1.6)	1,718	41.7	(1.3)
	Russian Federation[e]	2,175	30.5	(1.8)	2,142	37.1	(2.0)	2,152	31.2	(2.6)	2,149	59.0	(2.0)	2,192	90.9	(1.2)	2,134	4.6	(0.7)	2,146	63.9	(2.0)	2,147	42.0	(2.5)	2,148	42.6	(2.0)
	Switzerland[f]	113	24.8	(3.9)	112	12.6	(2.0)	114	16.3	(3.8)	113	93.2	(2.5)	114	100.0	(0.0)	112	36.6	(4.7)	112	80.0	(4.2)	111	98.1	(1.4)	111	52.8	(3.7)
Primary (to Grade 6 Maximum)	Chinese Taipei	921	11.3	(0.8)	922	6.5	(0.7)	921	13.6	(1.0)	922	47.1	(1.3)	921	59.8	(1.8)	922	57.1	(1.5)	921	60.1	(1.4)	921	54.4	(1.7)	920	75.4	(1.4)
	Philippines	505	60.2	(3.7)	501	63.4	(4.0)	501	70.2	(5.2)	491	77.9	(1.7)	488	84.0	(2.1)	484	29.9	(5.5)	473	83.5	(1.2)	473	85.3	(1.5)	468	79.6	(1.2)
	Singapore	263	32.4	(3.2)	262	25.6	(3.0)	261	53.4	(3.4)	262	76.4	(2.8)	261	88.2	(1.6)	262	31.7	(3.2)	263	85.6	(2.1)	260	77.3	(2.6)	262	53.2	(4.0)
	Spain	1,067	26.9	(1.9)	1,059	35.4	(2.4)	1,064	22.0	(1.1)	1,065	84.9	(1.7)	1,069	86.3	(1.4)	1,059	36.5	(2.1)	1,063	87.4	(1.4)	1,056	73.8	(1.5)	1,062	55.3	(2.7)
	Switzerland[f]	810	34.9	(2.0)	807	23.2	(1.2)	811	29.7	(1.8)	807	90.5	(1.1)	806	99.1	(0.3)	807	38.7	(1.3)	806	79.1	(1.3)	807	94.4	(0.7)	806	55.8	(1.9))
	United States[g]	1,031	35.4	(2.5)	1,029	19.9	(1.7)	1,019	22.3	(1.9)	1,030	90.9	(1.4)	1,024	97.5	(0.6)	1,026	7.7	(1.3)	1,029	94.7	(0.9)	1,026	77.9	(1.8)	1,027	52.3	(2.4)
Primary and Secondary Generalists (to Grade 6 Maximum)	Botswana[a]	46	50.9	(8.2)	38	39.6	(7.2)	44	88.4	(4.3)	43	71.6	(6.1)	42	75.8	(7.4)	37	16.0	(7.1)	35	82.5	(6.5)	36	63.2	(7.7)	33	50.4	(8.6)
	Chile[†b]	607	34.9	(1.7)	601	41.8	(2.1)	596	25.9	(1.4)	607	92.0	(1.3)	603	85.6	(1.4)	586	9.0	(1.3)	595	88.8	(1.5)	593	90.5	(1.3)	589	44.5	(1.5)
	Norway (ALU)[†c]	386	32.3	(2.9)	386	45.4	(2.4)	387	33.1	(2.2)	388	86.3	(1.6)	387	97.9	(0.8)	386	4.5	(1.4)	384	71.3	(1.8)	155	91.7	(1.1)	387	40.3	(2.6)
	Norway (ALU+)[†c]	157	28.9	(3.5)	156	39.9	(3.9)	157	77.2	(3.6)	156	87.7	(2.8)	155	96.7	(1.5)	155	6.0	(1.9)	155	66.9	(3.6)	386	90.1	(2.5)	154	30.1	(3.8)
Primary Mathematics Specialists	Germany[†]	91	51.5	(8.7)	91	26.9	(7.0)	90	73.6	(8.4)	91	88.2	(5.3)	92	98.2	(1.5)	90	29.5	(8.0)	91	81.3	(6.3)	91	88.7	(5.4)	91	42.2	(7.4)
	Malaysia	563	49.8	(2.1)	563	70.3	(2.4)	564	90.5	(1.2)	563	79.1	(1.6)	561	76.0	(1.6)	560	45.3	(2.1)	560	84.5	(1.6)	562	84.4	(1.8)	561	74.3	(1.6)
	Poland[†d]	293	30.8	(3.7)	294	6.9	(1.6)	295	67.2	(3.1)	294	49.7	(3.8)	293	68.2	(3.8)	293	4.5	(1.2)	290	34.5	(3.5)	293	49.1	(3.9)	292	40.4	(4.4)
	Singapore	117	33.4	(4.5)	117	21.1	(4.4)	117	72.0	(3.6)	117	79.8	(4.2)	116	90.7	(2.8)	117	24.5	(4.0)	117	89.9	(2.9)	116	73.2	(3.5)	117	48.3	(5.0)
	Thailand[†]	651	38.7	(2.0)	653	64.9	(1.8)	650	87.9	(1.4)	653	61.7	(1.7)	648	59.6	(1.7)	651	24.1	(1.5)	648	82.7	(1.2)	648	77.0	(1.5)	651	90.2	(1.3)
	United States[†g]	148	41.4	(8.8)	149	28.1	(5.9)	149	30.8	(6.8)	149	88.6	(1.7)	149	95.2	(2.2)	149	7.2	(3.4)	149	91.9	(4.8)	148	81.4	(5.8)	149	58.8	(6.4)

Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

Exhibit A4.24: Future lower-secondary teachers selecting significant or major reasons for becoming a teacher (estimated percent)

Program-Group	Country	Good Student			Available Positions			Love Mathematics			Talent Teaching			Like Working with Young People			Teacher Salaries			Next Generation			Challenging Job			Long-Term Security		
		Percent of Future Lower-Secondary Teachers in Response Categories (weighted estimates)																										
		n	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)	*n*	Est.	(*SE*)
Lower Secondary (to Grade 10 Maximum)	Botswana[a]	15	40.0	(15.4)	15	26.2	(11.9)	18	100.0	(0.0)	15	60.2	(15.4)	14	85.9	(9.0)	14	7.0	(6.8)	14	78.5	(12.5)	14	71.5	(13.1)	14	29.1	(13.4)
	Chile[†b]	675	34.1	(2.1)	672	36.5	(1.9)	656	27.6	(1.7)	680	93.7	(1.0)	661	88.3	(1.1)	653	8.1	(1.1)	665	87.1	(1.1)	657	88.6	(1.2)	630	40.8	(2.2)
	Germany[†]	404	44.1	(5.0)	404	33.9	(4.2)	405	76.9	(2.1)	404	85.8	(3.7)	406	97.8	(0.9)	406	41.3	(5.6)	406	71.7	(4.2)	403	88.3	(4.0)	404	53.8	(5.4)
	Norway (ALU)[†d]	351	28.2	(2.6)	351	45.8	(2.5)	349	32.9	(2.6)	348	87.8	(1.9)	349	95.8	(1.0)	347	4.8	(1.1)	345	73.2	(2.4)	345	92.9	(1.1)	344	46.6	(2.2)
	Norway (ALU+)[†d]	149	28.8	(3.6)	149	33.7	(3.9)	149	79.7	(4.1)	149	87.6	(2.1)	148	95.6	(1.7)	148	4.9	(1.7)	149	64.9	(4.2)	147	89.3	(2.7)	149	33.8	(3.0)
	Philippines	637	58.4	(1.7)	621	55.8	(2.8)	629	81.5	(3.1)	618	75.8	(3.6)	605	69.0	(2.1)	605	25.5	(2.4)	603	84.6	(1.9)	599	82.8	(2.8)	592	69.9	(3.0)
	Poland[†e]	157	32.0	(4.3)	157	5.7	(1.8)	157	57.0	(3.4)	157	47.3	(4.6)	157	67.1	(4.7)	156	1.5	(1.0)	156	28.5	(3.4)	156	51.1	(4.0)	157	33.1	(3.4)
	Singapore	138	35.0	(4.3)	139	21.9	(4.1)	139	51.7	(3.9)	139	69.8	(4.4)	140	84.9	(2.9)	139	30.4	(4.2)	139	80.7	(2.6)	138	62.7	(3.5)	139	35.3	(3.7)
	Switzerland[g]	140	34.9	(3.8)	140	36.6	(3.8)	140	76.0	(3.8)	140	90.8	(2.3)	140	95.9	(1.7)	140	48.7	(3.7)	138	73.3	(3.7)	140	88.0	(3.5)	140	59.6	(4.6)
	United States[†h]	131	35.5	(5.5)	131	39.6	(6.7)	129	38.5	(4.4)	131	89.2	(1.1)	129	96.8	(1.0)	131	6.4	(1.0)	130	94.1	(1.1)	131	77.1	(3.5)	130	59.1	(5.6)
Lower and Upper Secondary (to Grade 11 and above)	Botswana[†h]	5	80.0	(20.7)	5	40.0	(23.7)	6	100.0	(0.0)	5	100.0	(0.0)	5	100.0	(0.0)	5	0.0	(0.0)	5	100.0	(0.0)	5	100.0	(0.0)	5	20.0	(20.7)
	Chinese Taipei	365	12.0	(1.5)	364	9.6	(1.8)	364	72.6	(2.2)	365	57.6	(2.7)	364	64.1	(2.1)	364	46.8	(2.4)	364	63.5	(2.8)	364	59.5	(2.7)	364	68.7	(2.4)
	Georgia[c]	40	54.7	(8.6)	41	37.0	(6.5)	49	61.0	(5.9)	41	47.2	(7.7)	40	52.9	(7.2)	36	36.2	(6.9)	35	46.8	(10.0)	36	55.0	(9.1)	35	53.2	(8.8)
	Germany	357	47.4	(3.2)	361	47.8	(3.6)	359	85.0	(2.2)	361	87.6	(1.9)	360	92.8	(1.6)	359	34.5	(3.3)	361	57.4	(3.6)	360	79.2	(2.4)	360	57.2	(4.0)
	Malaysia	383	50.3	(2.3)	382	64.6	(1.8)	382	87.4	(1.4)	382	70.2	(2.3)	380	60.1	(2.3)	380	36.1	(2.2)	380	72.9	(2.5)	380	77.8	(2.4)	380	65.3	(2.2)
	Norway (PPU & Master's)[d]	64	28.4	(5.6)	64	33.5	(7.8)	64	95.5	(2.5)	64	81.3	(5.0)	65	87.6	(4.9)	64	3.9	(2.8)	64	58.7	(7.8)	64	91.1	(3.5)	64	28.3	(5.5)
	Oman	236	73.4	(2.8)	230	48.2	(3.8)	237	90.0	(2.0)	224	79.3	(3.2)	222	35.8	(3.1)	221	31.6	(3.2)	219	86.1	(2.0)	217	71.1	(2.8)	220	54.7	(3.0)
	Poland[e]	137	40.3	(3.5)	136	6.2	(2.5)	136	64.7	(5.4)	136	49.1	(6.3)	133	72.1	(4.7)	134	5.4	(4.8)	134	32.7	(4.9)	133	55.0	(4.6)	134	45.6	(5.1)
	Russian Federation[f]	2,097	32.7	(1.3)	2,068	23.4	(1.6)	2,104	77.7	(2.0)	2,054	40.3	(1.5)	2,081	66.3	(1.6)	2,057	4.2	(0.7)	2,055	45.2	(1.7)	2,053	27.2	(1.8)	2,069	29.0	(1.6)
	Singapore	249	43.4	(2.8)	248	18.6	(2.3)	249	74.3	(3.3)	249	73.5	(2.6)	247	83.8	(1.9)	249	27.3	(3.0)	249	78.7	(2.4)	249	69.5	(3.1)	249	37.8	(2.3)
	Thailand[†]	646	36.6	(2.1)	647	67.1	(1.8)	647	85.2	(1.3)	642	60.9	(2.2)	644	59.3	(1.7)	640	25.4	(1.5)	644	84.7	(1.4)	642	80.0	(1.6)	644	88.6	(1.1)
	United States[h]	363	45.9	(4.1)	365	31.4	(3.3)	363	85.8	(3.1)	366	90.6	(2.5)	364	92.9	(2.1)	364	6.7	(1.5)	363	90.1	(1.2)	363	75.2	(2.0)	363	51.1	(2.3)

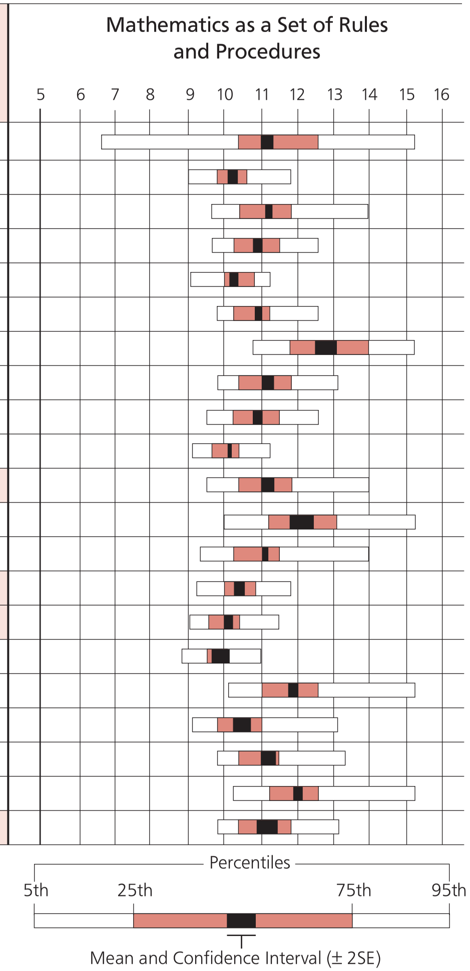
Notes:

1. † Some or all future teachers in this country are being prepared to teach primary and lower-secondary students. The program-groups preparing future primary teachers and the program-groups preparing lower-secondary teachers are therefore partly or fully overlapping (see TEDS-M technical report).
2. When reading this exhibit, keep in mind the limitations annotated in Chapter 4 and denoted in the table above by footnote letters.
3. The shaded areas identify data that, for reasons explained in these limitations, cannot be compared with confidence to data from other countries.

A3: CHAPTER 6 EXHIBITS

Exhibit A6.1: ***Mathematics is a set of rules and procedures:*** *future primary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	490	3.1	11.00	(0.09)
	Germany	935	886	3.1	10.09	(0.06)
	Poland [a]	1,812	1,775	2.5	11.07	(0.04)
	Russian Federation [b]	2,266	2,215	1.9	10.75	(0.05)
	Switzerland [c]	121	119	2.0	10.10	(0.06)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	10.75	(0.04)
	Philippines	592	589	0.9	12.64	(0.13)
	Singapore	263	261	0.8	11.06	(0.07)
	Spain	1,093	1,086	0.7	10.75	(0.05)
	Switzerland	815	812	0.4	9.98	(0.02)
	United States [†d]	1,310	1,005	24.1	11.02	(0.08)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[e]	86	86	0.0	11.96	(0.15)
	Chile [f]	657	634	3.5	10.88	(0.04)
	Norway (ALU) [g]	392	387	1.6	10.27	(0.04)
	Norway (ALU+) [g]	159	156	1.6	9.93	(0.07)
Group 4. Primary Mathematics Specialists	Germany	97	97	0.0	9.69	(0.10)
	Malaysia	576	562	2.4	11.74	(0.07)
	Poland [a]	300	298	0.7	10.32	(0.11)
	Singapore	117	116	0.9	11.02	(0.10)
	Thailand	660	653	1.1	11.86	(0.05)
	United States [†d]	191	144	25.6	11.01	(0.14)

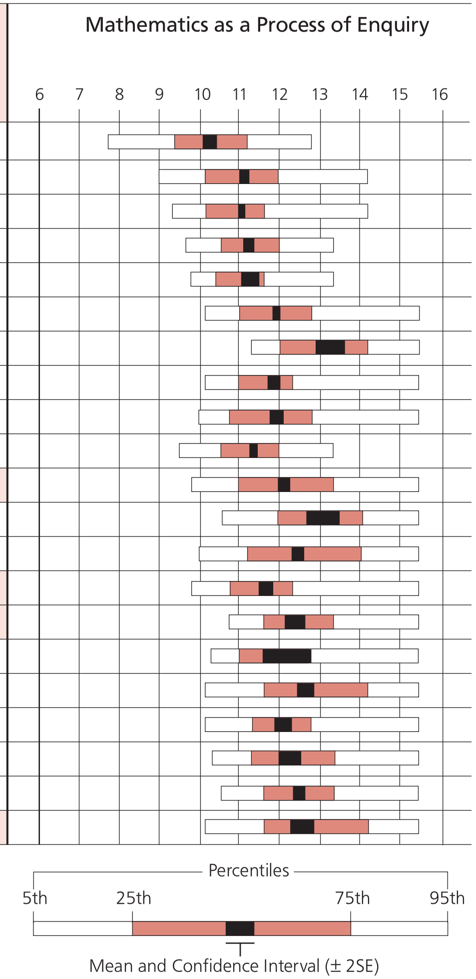


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.2: ***Mathematics is a process of enquiry:*** *future primary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	480	5.1	10.25	(0.07)
	Germany	935	886	3.1	11.09	(0.06)
	Poland [a]	1,812	1,770	3.1	11.03	(0.05)
	Russian Federation [b]	2,266	2,211	2.1	11.20	(0.07)
	Switzerland [c]	121	119	2.0	11.25	(0.10)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	11.94	(0.04)
	Philippines	592	587	1.0	13.25	(0.18)
	Singapore	263	261	0.8	11.86	(0.08)
	Spain	1,093	1,086	0.7	11.91	(0.07)
	Switzerland	815	812	0.4	11.33	(0.04)
	United States [†d]	1,310	1,005	24.1	12.12	(0.06)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[e]	86	85	1.0	13.09	(0.19)
	Chile [f]	657	635	3.3	12.43	(0.05)
	Norway (ALU) [g]	392	387	1.6	11.66	(0.08)
	Norway (ALU+) [g]	159	156	1.6	12.37	(0.11)
Group 4. Primary Mathematics Specialists	Germany	97	97	0.0	12.16	(0.29)
	Malaysia	576	562	2.4	12.63	(0.09)
	Poland [a]	300	297	1.0	12.07	(0.10)
	Singapore	117	116	0.9	12.28	(0.13)
	Thailand	660	653	1.1	12.48	(0.06)
	United States [†d]	191	144	25.6	12.55	(0.14)

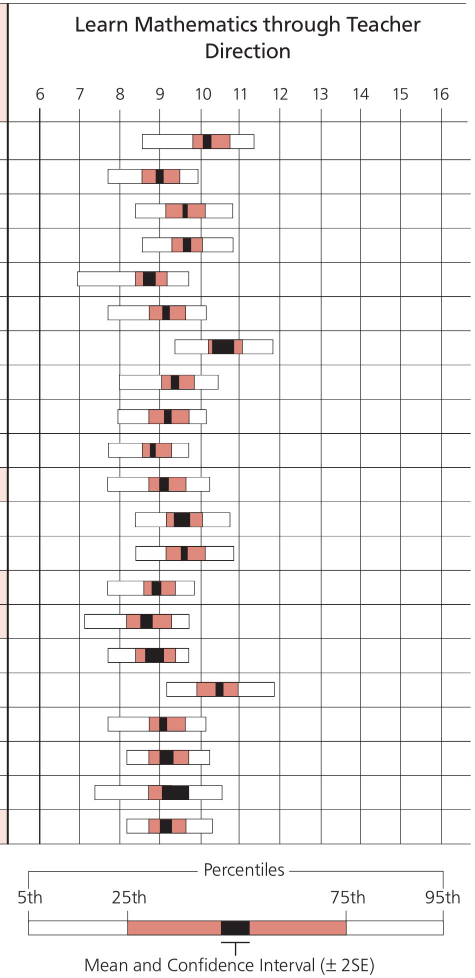


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.3: ***Learn mathematics through teacher direction:*** *future primary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	486	3.7	10.19	(0.04)
	Germany	935	885	3.3	8.98	(0.04)
	Poland [a]	1,812	1,775	2.8	9.61	(0.02)
	Russian Federation [b]	2,266	2,219	1.7	9.65	(0.04)
	Switzerland [c]	121	119	2.0	8.72	(0.06)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	9.12	(0.03)
	Philippines	592	586	1.4	10.57	(0.13)
	Singapore	263	261	0.8	9.36	(0.05)
	Spain	1,093	1,086	0.6	9.18	(0.03)
	Switzerland	815	811	0.5	8.82	(0.02)
	United States [†d]	1,310	1,005	24.1	9.10	(0.05)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[e]	86	84	2.2	9.54	(0.08)
	Chile [f]	657	635	3.4	9.60	(0.03)
	Norway (ALU) [g]	392	388	1.1	8.90	(0.05)
	Norway (ALU+) [g]	159	156	1.6	8.63	(0.08)
Group 4. Primary Mathematics Specialists	Germany	97	97	0.0	8.85	(0.11)
	Malaysia	576	562	2.5	10.46	(0.04)
	Poland [a]	300	298	0.7	9.07	(0.05)
	Singapore	117	117	0.0	9.16	(0.08)
	Thailand	660	653	1.1	9.14	(0.04)
	United States [†d]	191	144	25.6	9.15	(0.07)

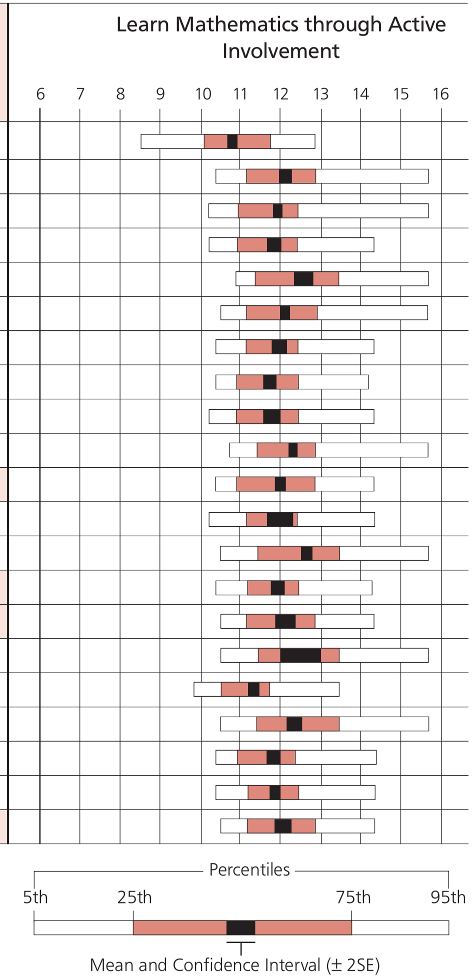


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.4: ***Learn mathematics through active involvement:*** *future primary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	476	5.7	10.81	(0.06)
	Germany	935	884	3.4	12.18	(0.06)
	Poland [a]	1,812	1,766	3.2	11.93	(0.05)
	Russian Federation [b]	2,266	2,218	1.7	11.83	(0.06)
	Switzerland [c]	121	119	2.0	12.59	(0.11)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	12.13	(0.04)
	Philippines	592	587	1.4	11.95	(0.09)
	Singapore	263	261	0.8	11.72	(0.07)
	Spain	1,093	1,085	0.9	11.78	(0.08)
	Switzerland	815	810	0.6	12.36	(0.04)
	United States †d	1,310	1,005	24.1	12.00	(0.06)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[e]	86	85	1.0	12.00	(0.16)
	Chile [f]	657	632	3.8	12.66	(0.06)
	Norway (ALU) [g]	392	385	1.9	11.94	(0.08)
	Norway (ALU+) [g]	159	156	1.6	12.12	(0.12)
Group 4. Primary Mathematics Specialists	Germany	97	97	0.0	12.50	(0.28)
	Malaysia	576	562	2.5	11.32	(0.05)
	Poland [a]	300	298	0.7	12.36	(0.09)
	Singapore	117	117	0.0	11.83	(0.08)
	Thailand	660	652	1.2	11.86	(0.05)
	United States †d	191	144	25.6	12.07	(0.09)

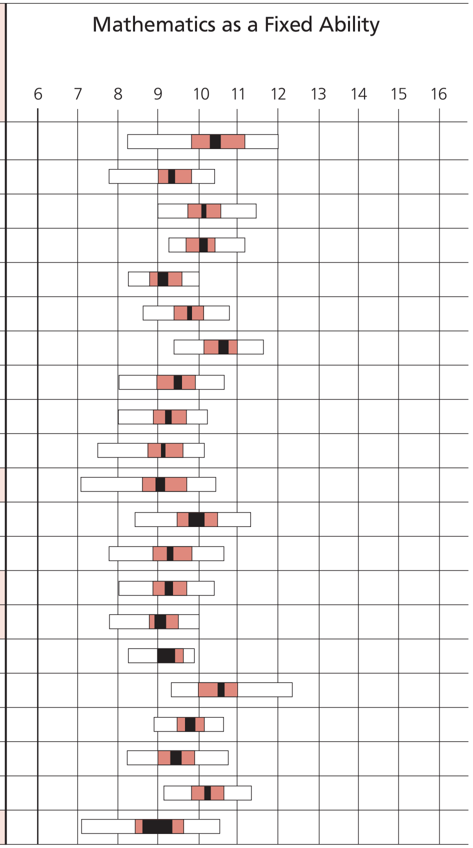


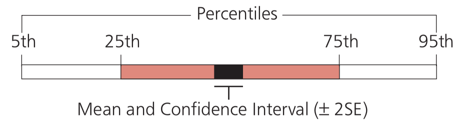
Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.5: ***Mathematics is a fixed ability:*** *future primary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 1. Lower Primary (to Grade 4 Maximum)	Georgia	506	459	9.1	10.41	(0.06)
	Germany	935	884	3.4	9.34	(0.04)
	Poland [a]	1,812	1,767	2.8	10.14	(0.02)
	Russian Federation [b]	2,266	2,212	2.0	10.13	(0.04)
	Switzerland [c]	121	118	3.0	9.13	(0.05)
Group 2. Primary (to Grade 6 Maximum)	Chinese Taipei	923	923	0.0	9.78	(0.02)
	Philippines	592	586	1.5	10.61	(0.06)
	Singapore	263	261	0.8	9.49	(0.04)
	Spain	1,093	1,082	1.0	9.26	(0.03)
	Switzerland	815	810	0.6	9.11	(0.03)
	United States †d	1,310	1,004	24.3	9.04	(0.06)
Group 3. Primary and Secondary Generalists (to Grade 10 Maximum)	Botswana[e]	86	86	0.0	9.95	(0.08)
	Chile [f]	657	631	3.9	9.30	(0.03)
	Norway (ALU) [g]	392	387	2.1	9.29	(0.04)
	Norway (ALU+) [g]	159	155	1.3	9.06	(0.05)
Group 4. Primary Mathematics Specialists	Germany	97	96	0.2	9.21	(0.09)
	Malaysia	576	561	2.7	10.58	(0.03)
	Poland [a]	300	296	1.1	9.80	(0.04)
	Singapore	117	117	0.0	9.45	(0.07)
	Thailand	660	653	1.1	10.24	(0.03)
	United States †d	191	144	25.6	8.97	(0.17)



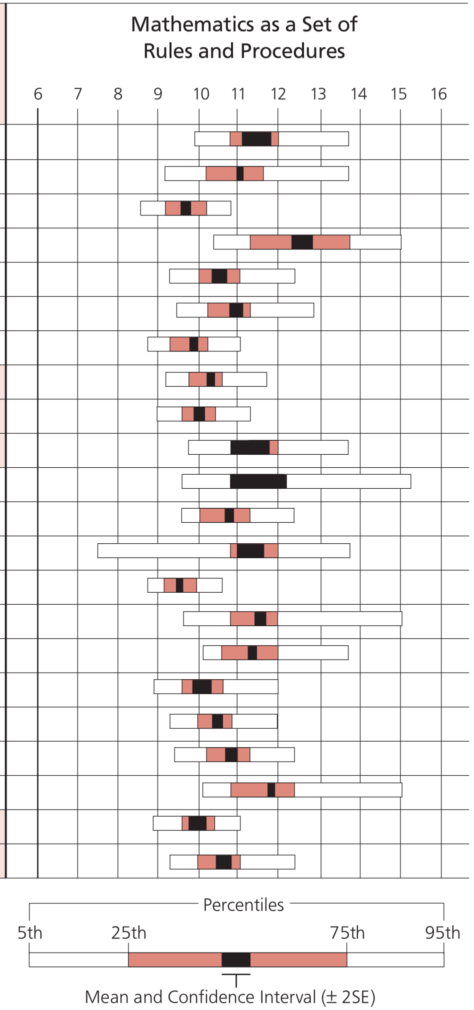


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.6: ***Mathematics is a set of rules and procedures:*** *future secondary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [a]	34	34	0.0	11.49	(0.17)
	Chile [b]	746	712	4.2	11.06	(0.04)
	Germany	408	403	1.4	9.73	(0.06)
	Philippines	733	729	0.6	12.61	(0.12)
	Poland [c]	158	155	1.4	10.56	(0.08)
	Singapore	142	142	0.0	10.98	(0.08)
	Switzerland [d]	141	140	0.7	9.86	(0.05)
	Norway (ALU) [e]	356	353	1.1	10.33	(0.05)
	Norway (ALU+) [e]	151	148	1.6	10.06	(0.06)
	United States [†f]	169	126	27.8	11.31	(0.23)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	19	0.0	11.56	(0.33)
	Chinese Taipei	365	364	0.3	10.81	(0.06)
	Georgia [g]	78	78	0.0	11.31	(0.16)
	Germany	363	357	1.1	9.59	(0.03)
	Malaysia	389	385	1.1	11.57	(0.07)
	Oman	268	267	0.4	11.38	(0.05)
	Poland	140	138	0.8	10.14	(0.10)
	Russian Federation [h]	2,141	2,093	2.2	10.51	(0.05)
	Singapore	251	251	0.0	10.88	(0.08)
	Thailand	652	644	1.2	11.86	(0.04)
	Norway (PPU & Master's) [e]	65	64	1.3	10.02	(0.09)
	United States [†f]	438	364	18.6	10.68	(0.08)



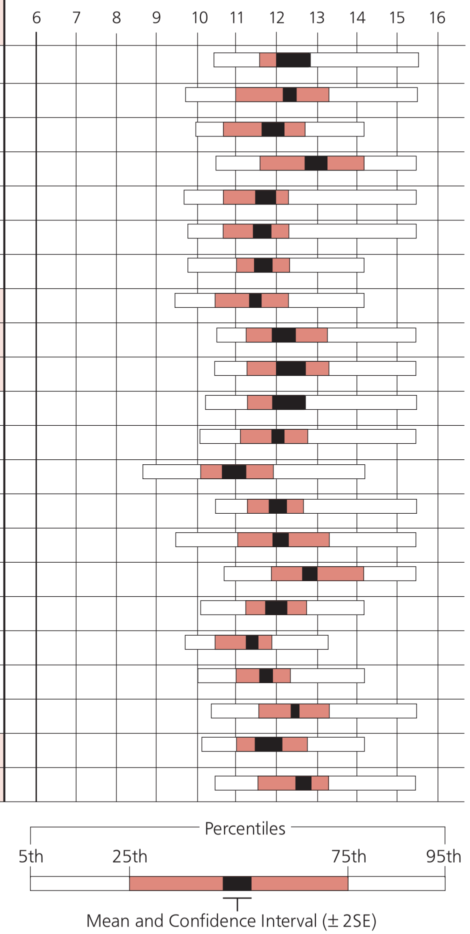
Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.7: ***Mathematics is a process of enquiry:*** *future secondary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [a]	34	34	0.0	12.43	(0.21)
	Chile [b]	746	712	4.2	12.34	(0.08)
	Germany	408	403	1.4	11.93	(0.13)
	Philippines	733	729	0.6	13.00	(0.13)
	Poland [c]	158	155	1.4	11.73	(0.12)
	Singapore	142	142	0.0	11.68	(0.11)
	Switzerland [d]	141	140	0.7	11.73	(0.10)
	Norway (ALU) [e]	356	352	1.4	11.50	(0.07)
	Norway (ALU+) [e]	151	148	1.6	12.21	(0.14)
	United States †f	169	126	27.8	12.36	(0.17)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	19	0.0	12.34	(0.20)
	Chinese Taipei	365	364	0.3	12.08	(0.07)
	Georgia [g]	78	78	0.0	10.98	(0.15)
	Germany	363	357	1.1	12.06	(0.11)
	Malaysia	389	385	1.1	12.11	(0.09)
	Oman	268	266	0.8	12.85	(0.09)
	Poland	140	138	0.8	12.02	(0.13)
	Russian Federation [h]	2,141	2,091	2.3	11.42	(0.06)
	Singapore	251	251	0.0	11.80	(0.07)
	Thailand	652	644	1.2	12.49	(0.05)
	Norway (PPU & Master's) [e]	65	64	1.3	11.83	(0.15)
	United States †f	438	364	18.6	12.68	(0.10)

Mathematics as a Process of Enquiry

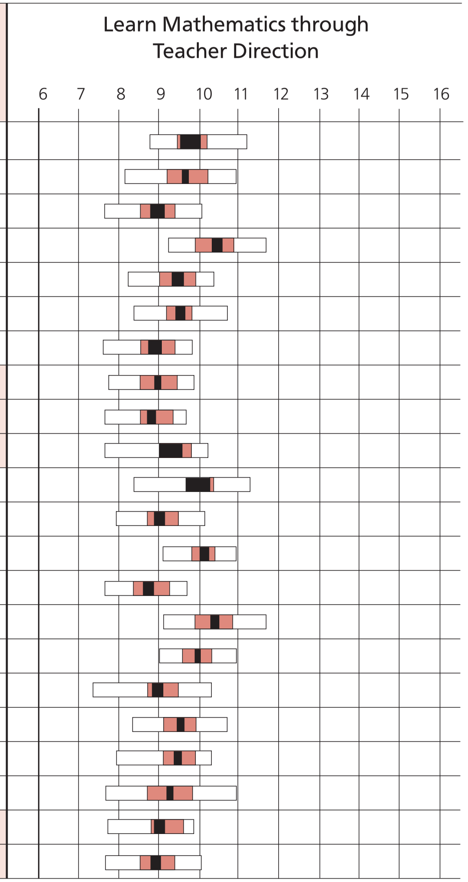


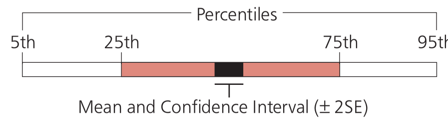
Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.8: ***Learn mathematics through teacher direction:*** *future secondary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [a]	34	34	0.0	9.78	(0.10)
	Chile [b]	746	714	4.0	9.68	(0.03)
	Germany	408	402	1.4	8.98	(0.08)
	Philippines	733	729	0.6	10.45	(0.06)
	Poland [c]	158	155	1.4	9.48	(0.07)
	Singapore	142	142	0.0	9.56	(0.06)
	Switzerland [d]	141	140	0.7	8.92	(0.07)
	Norway (ALU) [e]	356	354	0.7	8.98	(0.03)
	Norway (ALU+) [e]	151	148	1.6	8.84	(0.05)
	United States [†f]	169	126	27.8	9.28	(0.14)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	19	0.0	9.88	(0.14)
	Chinese Taipei	365	365	0.0	9.02	(0.04)
	Georgia [g]	78	78	0.0	10.13	(0.05)
	Germany	363	357	0.9	8.77	(0.06)
	Malaysia	389	386	0.8	10.39	(0.04)
	Oman	268	267	0.4	9.98	(0.03)
	Poland	140	138	0.8	8.98	(0.06)
	Russian Federation [h]	2,141	2,091	2.2	9.55	(0.03)
	Singapore	251	251	0.0	9.46	(0.04)
	Thailand	652	642	1.5	9.28	(0.04)
	Norway (PPU & Master's) [e]	65	64	1.3	9.03	(0.06)
	United States [†f]	438	364	18.6	8.94	(0.05)

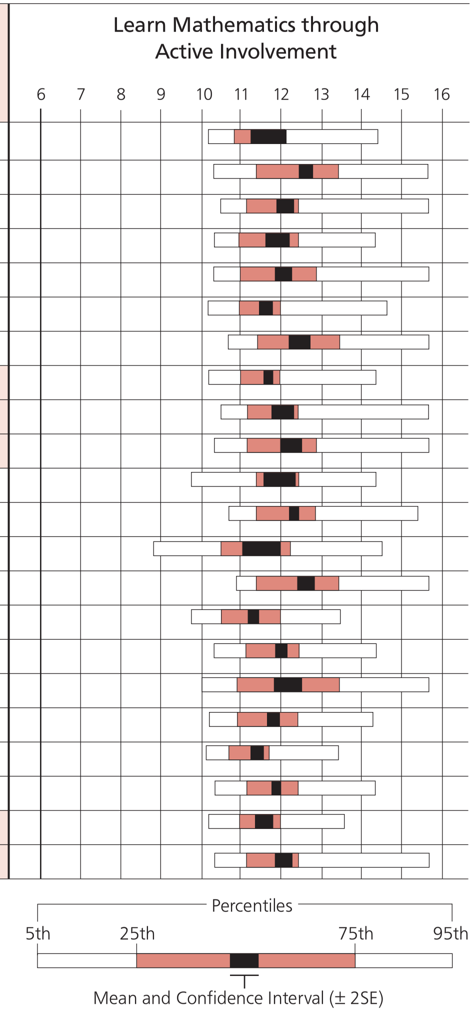




Notes:
1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.9: ***Learn mathematics through active involvement:*** *future secondary teachers' endorsement of this statement*

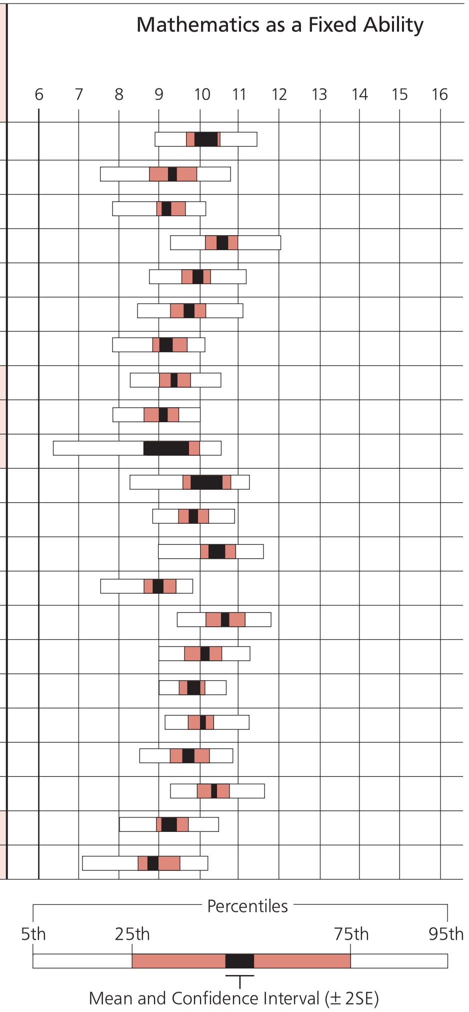
Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [a]	34	34	0.0	11.73	(0.21)
	Chile [b]	746	710	4.5	12.65	(0.08)
	Germany	408	402	1.4	12.12	(0.10)
	Philippines	733	728	0.6	11.92	(0.14)
	Poland [c]	158	155	1.4	12.09	(0.10)
	Singapore	142	142	0.0	11.67	(0.08)
	Switzerland [d]	141	140	0.7	12.49	(0.12)
	Norway (ALU) [e]	356	353	1.0	11.72	(0.06)
	Norway (ALU+) [e]	151	148	1.6	12.08	(0.13)
	United States [†f]	169	126	27.8	12.26	(0.14)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	19	0.0	12.01	(0.18)
	Chinese Taipei	365	365	0.0	12.36	(0.05)
	Georgia [g]	78	75	3.6	11.49	(0.20)
	Germany	363	356	1.4	12.67	(0.10)
	Malaysia	389	384	1.3	11.35	(0.06)
	Oman	268	267	0.4	12.03	(0.07)
	Poland	140	138	0.8	12.20	(0.17)
	Russian Federation [h]	2,141	2,084	2.4	11.85	(0.07)
	Singapore	251	250	0.4	11.45	(0.07)
	Thailand	652	640	1.8	11.92	(0.05)
	Norway (PPU & Master's) [e]	65	64	1.3	11.62	(0.10)
	United States [†f]	438	364	18.6	12.10	(0.10)



Notes:
1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.10: ***Mathematics is a fixed ability:*** *future secondary teachers' endorsement of this statement*

Program-Group	Country	Sample Size	Valid Data (*N*)	Percent Missing (Weighted)	Scaled Score: Mean	(*SE*)
Group 5. Lower Secondary (Grade 10 Maximum)	Botswana [a]	34	33	2.9	10.14	(0.13)
	Chile [b]	746	707	4.9	9.31	(0.05)
	Germany	408	402	1.4	9.16	(0.06)
	Philippines	733	725	0.8	10.57	(0.07)
	Poland [c]	158	155	1.4	9.94	(0.06)
	Singapore	142	141	0.7	9.73	(0.05)
	Switzerland [d]	141	140	0.7	9.17	(0.06)
	Norway (ALU) [e]	356	353	1.0	9.38	(0.03)
	Norway (ALU +) [e]	151	148	1.6	9.06	(0.05)
	United States †f	169	126	27.8	9.07	(0.28)
Group 6. Lower and Upper Secondary (to Grade 11 and above)	Botswana [a]	19	18	5.3	10.15	(0.19)
	Chinese Taipei	365	365	0.0	9.83	(0.04)
	Georgia [g]	78	75	4.3	10.41	(0.10)
	Germany	363	356	1.0	8.92	(0.05)
	Malaysia	389	383	1.5	10.63	(0.05)
	Oman	268	263	1.8	10.11	(0.05)
	Poland	140	137	1.9	9.85	(0.07)
	Russian Federation [h]	2,141	2076	2.6	10.08	(0.02)
	Singapore	251	249	0.8	9.71	(0.07)
	Thailand	652	642	1.5	10.36	(0.03)
	Norway (PPU & Master's) [e]	65	64	1.3	9.23	(0.08)
	United States †f	438	363	18.8	8.83	(0.06)

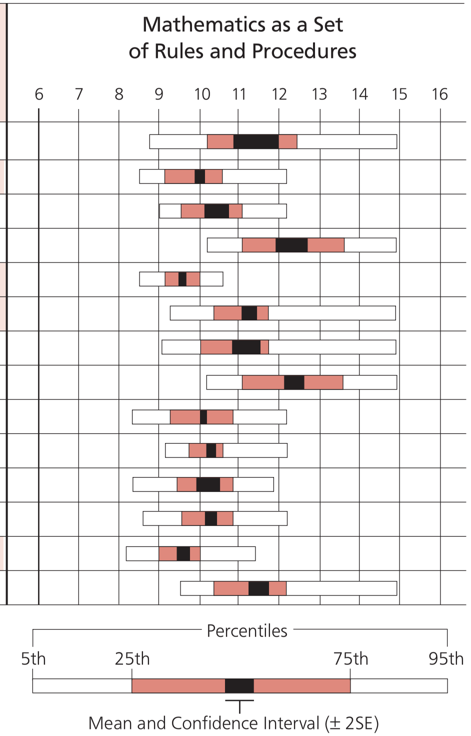


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The dagger symbol (†) is used to alert readers to situations where data were available from fewer than 85% of respondents.
3. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.11: ***Mathematics is a set of rules and procedures:*** *teacher educators' endorsement of this statement*

Country	Sample Size	Valid Data (*N*)	Missing Data (%)	Scaled Score: Mean	(*SE*)
Botswana	43	40	6.8	11.38	(0.26)
Chile [a]	392	380	2.9	10.01	(0.06)
Chinese Taipei	195	193	2.5	10.42	(0.13)
Georgia	62	62	0.0	12.27	(0.19)
Germany [b]	482	446	4.8	9.55	(0.05)
Malaysia [c]	255	250	1.7	11.24	(0.08)
Oman	84	72	14.3	11.14	(0.16)
Philippines	589	582	1.5	12.33	(0.12)
Poland [d]	734	701	4.8	10.07	(0.04)
Russian Federation [e]	1,212	1,191	1.8	10.29	(0.06)
Singapore	77	74	3.9	10.21	(0.14)
Spain	533	518	3.0	10.28	(0.06)
Switzerland [f]	220	213	2.7	9.57	(0.07)
Thailand	312	303	2.8	11.47	(0.12)

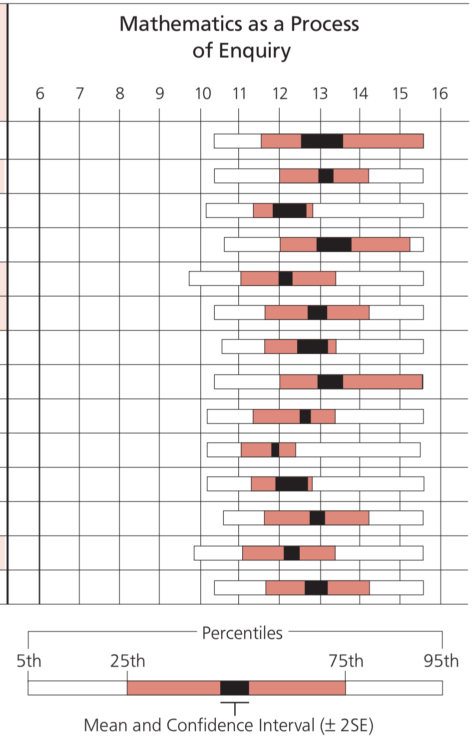


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.12: ***Mathematics is a process of enquiry:*** *teacher educators' endorsement of this statement*

Country	Sample Size	Valid Data (*N*)	Missing Data (%)	Scaled Score: Mean	(*SE*)
Botswana	43	40	6.8	13.05	(0.25)
Chile [a]	392	380	2.9	13.12	(0.08)
Chinese Taipei	195	193	2.5	12.22	(0.20)
Georgia	62	62	0.0	13.29	(0.22)
Germany [b]	482	446	4.8	12.14	(0.08)
Malaysia [c]	255	250	1.7	12.93	(0.11)
Oman	84	73	13.3	12.80	(0.18)
Philippines	589	581	1.5	13.24	(0.15)
Poland [d]	734	703	4.3	12.63	(0.06)
Russian Federation [e]	1,212	1,192	1.7	11.88	(0.05)
Singapore	77	74	3.9	12.29	(0.19)
Spain	533	521	2.3	12.91	(0.08)
Switzerland [f]	220	213	2.7	12.30	(0.08)
Thailand	312	303	2.8	12.89	(0.13)

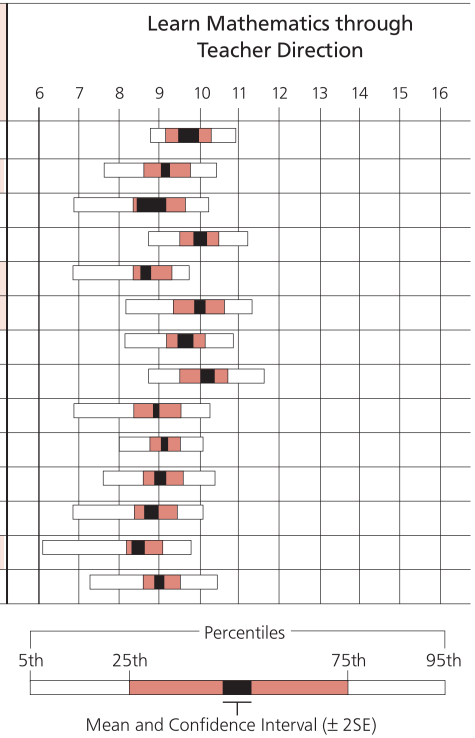


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.13: ***Learn mathematics through teacher direction:*** *teacher educators' endorsement of this statement*

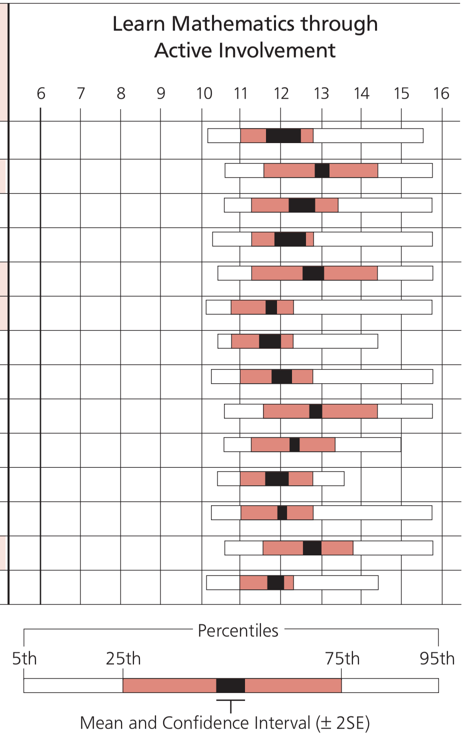
Country	Sample Size	Valid Data (*N*)	Missing Data (%)	Scaled Score: Mean	(*SE*)
Botswana	43	41	4.5	9.70	(0.12)
Chile [a]	392	379	3.1	9.14	(0.04)
Chinese Taipei	195	194	0.3	8.81	(0.17)
Georgia	62	62	0.0	10.02	(0.08)
Germany [b]	482	446	4.6	8.67	(0.06)
Malaysia [c]	255	251	1.4	10.01	(0.04)
Oman	84	75	10.7	9.65	(0.09)
Philippines	589	578	2.2	10.19	(0.10)
Poland [d]	734	704	4.3	8.93	(0.04)
Russian Federation [e]	1,212	1194	1.5	9.14	(0.03)
Singapore	77	74	3.9	9.03	(0.07)
Spain	533	523	2.0	8.81	(0.05)
Switzerland [f]	220	211	3.5	8.51	(0.07)
Thailand	312	305	2.3	9.00	(0.06)



Notes:
1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.14: ***Learn mathematics through active involvement:*** *teacher educators' endorsement of this statement*

Country	Sample Size	Valid Data (*N*)	Missing Data (%)	Scaled Score: Mean	(*SE*)
Botswana	43	41	4.5	12.05	(0.21)
Chile [a]	392	379	3.1	13.02	(0.08)
Chinese Taipei	195	195	0.0	12.53	(0.16)
Georgia	62	62	0.0	12.21	(0.19)
Germany [b]	482	446	4.6	12.81	(0.12)
Malaysia [c]	255	250	1.7	11.76	(0.06)
Oman	84	75	10.7	11.75	(0.14)
Philippines	589	578	2.2	12.02	(0.11)
Poland [d]	734	704	4.3	12.82	(0.06)
Russian Federation [e]	1,212	1,195	1.4	12.31	(0.04)
Singapore	77	74	3.9	11.89	(0.13)
Spain	533	522	2.2	12.03	(0.06)
Switzerland [f]	220	211	3.5	12.77	(0.11)
Thailand	312	305	2.3	11.86	(0.09)

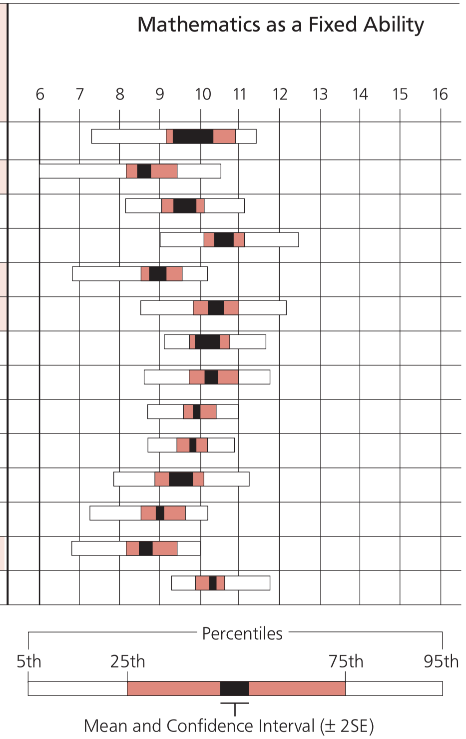


Notes:

1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

Exhibit A6.15: ***Mathematics is a fixed ability:*** *teacher educators' endorsement of this statement*

Country	Sample Size	Valid Data (*N*)	Missing Data (%)	Scaled Score: Mean	(*SE*)
Botswana	43	41	4.5	9.80	(0.24)
Chile [a]	392	375	4.0	8.59	(0.07)
Chinese Taipei	195	195	0.0	9.59	(0.13)
Georgia	62	62	0.0	10.58	(0.11)
Germany [b]	482	445	5.6	8.92	(0.09)
Malaysia [c]	255	250	1.8	10.37	(0.08)
Oman	84	73	13.7	10.17	(0.15)
Philippines	589	580	1.8	10.28	(0.07)
Poland [d]	734	701	5.0	9.92	(0.04)
Russian Federation [e]	1,212	1,191	1.6	9.81	(0.03)
Singapore	77	74	3.9	9.50	(0.13)
Spain	533	518	2.7	8.98	(0.04)
Switzerland [f]	220	209	4.2	8.62	(0.07)
Thailand	312	306	1.9	10.30	(0.03)



Notes:
1. This table and chart must be read with awareness of the limitations annotated in Chapter 6.
2. The shaded areas identify data that, for reasons explained in the limitations, cannot be compared with confidence to data from other countries.

A4: CHAPTER 7 EXHIBITS

*Exhibit A7.1: Areas of tertiary-level mathematics included in the OTL questionnaire**

Question 1. "Consider the following topics in university level mathematics. Please indicate whether you have ever studied each topic. Check one box in each row. Studied/Not studied"

Geometry
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 & Logic
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 & Functions
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 & Statistics
Q. Probability
R. Theoretical or applied statistics

Note: *Items that had poor fit were eliminated from the scale.

Exhibit A7.2. Areas of school-level mathematics included in the OTL questionnaire

Question 2. "Consider the following list of mathematics topics that are often taught at the <primary> or <secondary> school level. Please indicate whether you have studied each topic as part of your current teacher preparation program. Check one box in each row. Studied/ Not studied"

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, and Calculus MFB2SLMF
D. Functions, Relations, and Equations (e.g., algebra, trigonometry, analytic geometry)
E. Data Representation, Probability, and Statistics
F. Calculus (e.g., infinite processes, change, differentiation, integration)
G. Validation, Structuring, and Abstracting (e.g., Boolean algebra, mathematical induction, logical connectives, sets, groups, fields, linear space, isomorphism, homomorphism)

Exhibit A7.3: Future primary teachers: topics on mathematics pedagogy studied

Question 4. "Consider the following list of mathematics pedagogy topics. Please indicate whether you have studied each topic as part of your current teacher preparation program. Check one box in each row. Studied/ Not studied"

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

D. Mathematics instruction (e.g., representation of mathematics content and concepts, teaching methods, analysis of mathematical problems and solutions, problem posing strategies, teacher-pupil interaction)
E. Developing teaching plans (e.g., selection and sequencing the mathematics content, studying and selecting textbooks and instructional materials)
F. Mathematics teaching: observation, analysis and reflection
G. Mathematics standards and curriculum
H. Affective issues in mathematics (e.g., beliefs, attitudes, mathematics anxiety)

Exhibit A7.4: All future teachers: topics on general pedagogy studied

Question 7. "Consider the following in education pedagogy topics. Please indicate whether you have studied each topic as part of your current teacher preparation program. Check one box in each row. Studied/ Not studied"

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 educational systems, education and social conditions, diversity, educational reform)

Application MFB7EPAP

D. Educational Psychology (e.g., motivational theory, child development, learning theory)
E. 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)
F. Methods of Educational Research (e.g., read, interpret and use education research; theory and practice of action research)
G. Assessment and Measurement: Theory and Practice
H. Knowledge of Teaching (e.g., knowing how to teach pupils of different backgrounds, use resources to support instruction, manage classrooms, communicate with parents)

Exhibit A7.5: All future teachers: topics on teaching diverse students studied

Question 8. "In your teacher preparation program, how often did you have the opportunity to do the following? Check one box in each row. Often / Occasionally / Rarely / Never"

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

Exhibit A7.6: All future teachers: items in the classroom to practice index

Question 13. "During the school experience part of your program, how often were you required to do each of the following? Check one box in each row. Often / Occasionally / Rarely / Never"

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>

Exhibit A7.7: All future teachers: items in the teacher education program coherence index

Question 15. "Consider all of the <courses> in the program including subject matter <courses> (e.g., mathematics), mathematics <pedagogy> <courses>, and general education <pedagogy> <courses>. Please indicate the extent to which you agree or disagree with the following statements. Check one box in each row. Agree / Slightly agree / Slightly disagree / Disagree"

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.

APPENDIX B:

SAMPLING, SCALING, AND REPORTING PROCEDURES

The methodology of TEDS-M is described in detail in the TEDS-M technical report (Tatto, 2012), which is also available on the official TEDS-M website (http://teds.educ.msu.edu/). This technical appendix contains basic information that allows readers to understand the key definitions and methods used in the study.

B.1 Sampling

B.1.1 International Sampling Plan

The Teacher Education Development Study–Mathematics (TEDS-M) surveyed, as part of its data-collection plan, each of the study's target populations. The populations of interest included institutions where future primary and secondary teachers were receiving their preparation to teach mathematics, the teacher educators who were preparing them in mathematics and mathematics pedagogy as well as in general pedagogy, and the future teachers in their last year of training. The international sampling plan used a stratified multi-stage probability sampling design. The targeted individuals (teacher educators and future teachers) were randomly selected from a list of in-scope teacher educators and future teachers for each of the randomly selected teacher preparation (TP) institutions.

Note: Programs and routes

Two concepts play a key role in how TP is organized—the program and the route. A program is a specific pathway that exists within an institution, and it is where students undertake a set of subjects and experiences that lead 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. For the purposes of TEDS-M, two kinds of routes were defined:

- *Concurrent routes:* these consist 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.
- *Consecutive routes:* these consist of a first phase involving 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). A route cannot be considered consecutive if the institution or the government authorities do not award a degree, diploma, or official certificate at the end of the first phase. The first and second phases do not need to be completed in the same institution. In some education systems, it is customary for future teachers to complete the first and second phases in different institutions, or they may even be required to do this.

B.1.2 Target Populations: International Requirements and National Implementation

The sampling frame for TEDS-M included all programs in target countries preparing persons to teach mathematics at primary and lower-secondary school levels. Both concurrent and consecutive programs were of interest. Programs were sampled within countries, and then individuals were sampled from the programs. *The international target population of TP institutions was defined as follows:*

> The set of secondary or post-secondary schools, colleges, or universities which offer structured "opportunities to learn" (i.e., a program or programs) on a regular and frequent basis to future teachers within a route of teacher preparation.[1]

The national research coordinators (NRCs) for each participating country were asked to list all routes where TP programs could be found and to indicate which were of principal interest (i.e., a major route) to TEDS-M and which were of marginal interest. Each NRC and the sampling team sought agreement as to which routes would constitute the national desired target population for the country of interest. Countries could also opt to exclude routes or institutions of very small size. (The remaining populations are referred to, within the context of TEDS-M, as the national defined target populations.) A TP institution did not have to be teaching mathematics content in order to be part of the target population. However, it was necessary for the institution to be teaching mathematics pedagogy.

The *target population of educators* was determined as all persons with regular, repeated responsibility for teaching future teachers within given TP programs. This 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 TP 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; and
- *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.

The *target population of future teachers* was to include 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.

TEDS-M distinguished between two different groups of future teachers: future teachers who would be certified to teach primary students (ISCED Level 1; primary or basic education, Cycle 1) and future teachers who would be certified to teach lower-secondary students (ISCED Level 2; lower-secondary or basic education, Cycle 2).[2] TEDS-M refers to these two groups as two distinct "levels."

1 Readers are also referred to the TEDS-M conceptual framework (Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008) for key definitions.

2 ISCED levels as classified by UNESCO (1997).

In some countries, it is not possible to distinguish between primary and lower-secondary levels. Teachers may be prepared for both levels because they will be expected to teach at any level from Grade 1 to Grade 8 in the school where they eventually work. Where this was the case, TEDS-M randomly selected some future teachers to complete the knowledge tests and answer the survey for future primary teachers, and randomly selected others to complete the tests and answer the survey targeting future lower-secondary teachers.

B.1.3 Sample Size Requirements and Implementation

To allow for reliable estimation and modeling as well as some degree of non-response, TEDS-M set the *minimum* sample size as:

- Fifty institutions per route and level;
- Thirty (or all) mathematics and mathematics pedagogy educators; and
- Thirty (or all) educators of general pedagogy per selected institution.

The study set an *effective* sample size as 400 future teachers per route and level in a given country.[3] "Effective sample size" means that the sample design must be as efficient (i.e., precise) as a simple random sample of 400 teachers from a (hypothetical) list of all eligible future teachers found in a level and a route.

When the TEDS-M two-stage sample design was implemented, it was apparent that the sample size required for each level and route was larger than the nominal 400. This occurred because two-stage sample designs are typically less precise than a simple random sample due to the clustering effect. The actual number of future teachers required for each level and each route within the selected TP institutions and overall was dictated mainly by the following:

- The total number of institutions in the country;
- The sizes of the institutions in the country; and
- The selection method used in the institutions.

TP institutions offering education to both future primary and future lower-secondary school teachers could be part of both samples. Similarly, TP institutions offering more than one route to students could be part of more than one sample. Twelve out of the 17 countries participating in TEDS-M identified fewer than 50 (or only slightly more than 50) eligible institutions; these countries conducted a census of institutions.

For operational purposes, TEDS-M divided each institution in the sample into subgroups that were defined by level by route by program-type combinations. These subgroups, called "teacher preparation units" (TPUs), comprised the actual programs offered in a given institution.

Every future teacher in-scope for TEDS-M had to be allocated to exactly one and only one TPU. The minimum sample size of future teachers within institutions was set to 30 future teachers per TPU. TPUs with fewer than 30 future teachers in their final year

3 The numbers 50 and 30 were set after discussion between the TEDS-M sampling referee and the international study center at Michigan State University in consultation with advisors to TEDS-M and with reference to knowledge gained from the pre-TEDS-M planning study. TEDS-M considered these numbers as reasonable given the expected population sizes in the countries and institutions of interest; it was expected that these numbers would already exceed the actual numbers in the countries and institutions. After more within-country exploration, the TEDS-M and within-country sampling experts ended up conducting censuses in most institutions. Note that IEA surveys use 400 as the "golden yardstick" with respect to estimating the prevalence of some feature (with $p = 0.50$, $s(p) = 2.5\%$, and confidence intervals of 10% in width).

of study, or where the sampling of future teachers would have resulted in a sampling fraction of more than 50%, were to be surveyed in full. In countries where the number of TP institutions in a participating country was small, or where the institutions themselves were small, on average, all eligible future teachers had to be selected for the survey in order to reach the TEDS-M precision requirements. Exclusions could not exceed five percent of the national desired target population.

B.1.4 Sample Selection

B.1.4.1 Sampling of institutions

Where required, TEDS-M used systematic random sampling within explicit strata, according to the national sampling plans, to select samples of institutions. If reliable measures of size for the institutions were available, TEDS-M applied sampling with probability proportional to size (PPS). If the institutions were so small that censuses of individuals within the institutions were expected, sampling with equal probabilities was employed.

When implicit stratification was used, TEDS-M sorted institutions in explicit strata by implicit strata 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 to the sample of institutions. Non-responding individuals, teacher educators, and future teachers could not be replaced.

B.1.4.1.1 Sampling within institutions: teacher educators

For each selected institution, TEDS-M compiled a comprehensive list of eligible teacher educators. Each teacher educator then had to be allocated to one of the teacher educator groups. TEDS-M used software (WinW3S—within institution sampling software) provided by the IEA Data Processing and Research Center (DPC) to select a systematic random sample of at least 30 mathematics/mathematics-pedagogy teacher educators and a systematic random sample of 30 general-pedagogy teacher educators. In many institutions in all participating countries, TEDS-M had to conduct a census of teacher educators because there were fewer than 30 such educators in given groups.

B.1.4.1.2 Sampling within institutions: future teachers

In order to select future teachers within TPUs, TEDS-M implemented two different procedures, both of which required use of WinW3S:

1. *Selection of whole-session groups:* some TEDS-M participating countries (e.g., Germany, Chinese Taipei, the Russian Federation) or some selected institutions were grouping future teachers together for organizational purposes. TEDS-M called these groups "session groups." In very large institutions, in particular, TEDS-M found that it was sometimes operationally desirable and more convenient to select whole-session groups instead of individual future teachers. The downside of this sampling approach is that the sampling design is usually less efficient because of the impact that clustering effects can have on such groups.

   TEDS-M addressed this concern by appraising each situation and, when deemed necessary, increasing the within-institution sample sizes. A comprehensive list of session groups was compiled whenever this approach was used. Each eligible future teacher in a TPU was allocated to one, and only one, session group. Next, predetermined numbers of session groups were randomly selected with equal probability. TEDS-M then asked all future teachers within the selected session groups to participate in the study.

2. *Selection of individual future teachers:* TEDS-M compiled a comprehensive list of eligible future teachers for each TPU and then randomly selected at least 30 (or all) future teachers for that TPU.

All sampling procedures and processes were extensively documented either by the sampling team (institution samples) or automatically by WinW3S. This approach meant that every selection step could be reproduced at any time.

B.2 Participation Rates and Adjudication

The TEDS-M quality standards required minimum participation rates for all its target populations. This requirement was necessary to ensure that any reported statistics purporting to describe characteristics of those populations did indeed do this. The aim of these standards was to ensure that bias resulting from non-response was kept within acceptable limits. TEDS-M calculated and reported, separately for each country, participation rates for the four TEDS-M target populations. Reports describing the results for each target population consider the participation rate for that population only.

In essence, the minimum requirement that TEDS-M had to meet in order to publish statistical key data for international comparisons for each population was either

- that the overall (combined) participation rate (weighted or unweighted) of that population was at least 75%
  or
- that the participation rate (weighted or unweighted) of institutions for the considered population and the participation rate for individuals within the participating institutions were both at least 85%.

Chapter 11 of the TEDS-M technical report (Tatto, 2012, and also available on the official TEDS-M website) provides a detailed description of the calculation procedures for the different participation rates.

In this appendix we present an exhibit (Exhibit B.1 below) that summarizes all adjudication comments for each participating country and for each of the four TEDS-M survey populations (institutions, teacher educators, future primary teachers, and future lower-secondary teachers). The sampling adjudication meetings took place at the Michigan State International Research Center either as face-to-face meetings or via teleconference. The meetings were attended by the study director and co-directors, two sampling referees from Statistics Canada, and a representative of the IEA DPC's sampling team.

After completing the adjudication, the adjudication team made recommendations on reporting TEDS-M data. For each country and for each data source (institutions, teacher educators, future primary teachers, and future lower-secondary teachers), the team judged the extent to which the IEA sampling standards had been met, and then recommended which of the following annotations/actions should be implemented:

1. *Reporting without any annotation:* this comment applied if all participation-rate requirements were met, the exclusion rate was below five percent, and full coverage of the target population was observed.

2. *Annotation because of low participation rates:* this comment applied if the participation rate was below the requirement but the combined participation rate was still above 60%. Annotation was also advised if the exclusion rate exceeded five percent or if reduced coverage of the target population was observed.
3. *Participation rates lower than those stipulated in (2) above, and direct comparison with other countries therefore not advisable:* this comment was used if the combined participation rate dropped below 60% but was still above 30%. These countries and populations are signaled in TEDS-M reports via a color band that alerts readers to the likelihood of participation introducing bias in the results.
4. *Unacceptable:* this comment refers to situations where the combined participation rate dropped below 30% percent. Data for that country were not included in the report.

Exhibit B.1 summarizes the results of the adjudication, with these results being used to annotate the presentation of country-specific data as required in the TEDS-M reports. Details of participation rates, samples, and populations sampled and samples achieved are presented elsewhere in Appendix B.

B.3 Weights, Estimation, and Sampling Error

Selection of representative samples of institutions, future primary and future lower-secondary teachers and their educators was a key component of the TEDS-M survey. As an essential part of their sampling activities, NRCs provided detailed documentation describing their national sampling plans (structure of mathematics teacher education and educational institutions, including measures of size and the institution sampling frame).

DPC staff selected the institution samples, but the national teams were responsible for selecting the samples of future teachers and teacher educators within the selected institutions. Teams used the WinW3S software provided by the IEA DPC to carry out this work.

The DPC sampling team reviewed and completed all sampling documentation, including details on coverage and exclusions, and stratification. This documentation was also used to evaluate the quality of the samples.

The international sampling plan was prepared as a self-weighting design, which meant that each individual would have the same final estimation weight. However, the actual conditions in the field made that ideal plan impossible to execute. In the end, each national sampling plan was deemed unique, with the total complement of plans ranging from a stratified multi-stage probability sampling plan with unequal probabilities of selection to a simple and complete census of all units of interest.

B.3.1 Computing Estimation Weights and Estimates

Most of the statistics produced for TEDS-M were derived from data obtained through samples of institutions, educators, and future primary and future 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.

Exhibit B.1: Summary of annotation recommendations

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 B.1: Summary of annotation recommendations (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)	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.

In countries where censuses are conducted, it is sufficient to adjust the collected data for non-response in order to obtain unbiased estimates of the population parameters. When the sample design is complex and involves stratification and unequal probabilities of selection, estimation weights are required to achieve unbiased estimates (Lohr, 1999).

Estimation weights are the product of one or many design or base weights and one or many adjustment factors; the former are the inverse of the selection probability at each selection stage, and the latter compensate for non-response, again at each selection stage. These design weights and adjustment factors are specific to each stage of the sample design and to each explicit stratum. Because each country participating in TEDS-M had to adapt the general TEDS-M sample design to its own conditions, the estimation weights had to conform to the national adaptations.

Usually, one set of estimation weights is produced for each participating country. However, in the case of TEDS-M, four sets of estimation weights were required to reflect the various TEDS-M surveys: the institutions, the teacher educators, the future teachers of primary school mathematics, and the future teachers of lower-secondary school mathematics.

All estimates computed for any one of the four TEDS-M surveys were produced using the appropriate estimation weight, as developed by Horwitz-Thompson (Lohr, 1999). Chapter 11 of the IEA technical report (Tatto, 2012) provides a detailed description of how TEDS-M calculated the different weight components and the resulting estimation weights for the four populations.

B.3.2 Estimating Sampling Error

Surveys with complex designs such as TEDS-M require special attention to estimation, especially estimation of the sampling error. Both the survey design and the unequal weights need to be taken into account in order to obtain (approximately) design-unbiased estimates of sampling error. (Failure to do this can lead to severe underestimation of the sampling error.)

TEDS-M adopted the balanced repeated replication (BRR) technique (McCarthy, 1966) to estimate sampling error. More specifically, TEDS-M used the variant of this technique known as Fay's method (Fay, 1989). BRR is a well-established and documented technique that is used in other international educational studies, notably the Programme for International Student Assessment (PISA) and the Teaching and Learning International Survey (TALIS), both conducted by the Organisation for Economic Co-operation and Development (OECD). Chapter 11 of the TEDS-M technical report (Tatto, 2012) describes how the replicates were created and how the BRR estimates of sampling error were computed for TEDS-M. These estimates of the sampling error are another key element of the statistical quality of survey outcomes.

Note: The need for precision

Reporting measures of precision are necessary to enable readers to evaluate the confidence and accuracy of any given estimate. Exhibits B.2 to B.6 provide further information on the results of the sampling processes.

Exhibit B.2: 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			Teacher Educators		
	IPRI (%)	IPRIp (%)	WPRp (%)	CPRp (%)	IPRIs (%)	WPRs (%)	CPRs (%)	IPRe (%)	WPRe (%)	CPRe (%)
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	81	78	63	73	79	58	Data not processed		
Oman	100	Not applicable			100	93	93	100	85	85
Philippines	85	80	91	75*	91	92	83	85	94	80
Poland	86	86	79	68	82	84	69	79	86	68
Russia	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)	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, Concurrent and Consecutive Routes Only)	83	85	85*	71	82	84	69	23	58	14

Note: * Unweighted participation rate.

Exhibit B.3: Institutions: expected and achieved sample sizes

Country	Number of Institutions in Original Sample	Ineligible Institutions	Total Number of Institutions Providing Response to 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	47	2	43	43	43
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)	16	0	15	32	28
Thailand	46	0	44	53	51
United States (Public Institutions, Concurrent and Consecutive Routes Only)	60	0	50	136	117

Exhibit B.4: 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	32	0	26	709	551
Oman	Not applicable				
Philippines	60	19	33	653	592
Poland	91	0	78	2,673	2,112
Russian Federataion	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)	14	0	14	1,230	936
Thailand	46	0	45	666	660
United States (Public Institutions, Concurrent and Consecutive Routes Only)	60	0	51	1,807	1,501

Exhibit B.5: 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	47	2	33	724	572
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)	6	0	6	174	141
Thailand	46	0	45	667	652
United States (Public Institutions, Concurrent and Consecutive Routes Only)	59	3	46	726	607

Exhibit B.6: 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)	16	0	12	318	220
Thailand	46	0	43	331	312
United States (Public Institutions, Concurrent and Consecutive Routes Only)	60	0	14	407	241

B.4 Calibration and Scale Development

B.4.1 Methods Used to Determine MCK and MPCK Scales and Anchor Points

The TEDS-M tests of future teachers' mathematics content knowledge (MCK) and mathematics pedagogical content knowledge (MPCK) used a balanced-incomplete-block design so that the desired content would be well covered while simultaneously allowing the test to be completed within a reasonable administration time. Achieving this aim meant that each future teacher was given only a portion of the full set of items.

Because the set of items taken by each teacher was not comparable, summing the scores on the items taken by that person would not have yielded meaningful results. If summed scores were to be comparable, all of the test booklets would have to be constructed to be equivalent in content and difficulty. This was not possible because of the complexity of the content domains. To obtain comparable estimates of performance, TEDS-M used item response theory (IRT). IRT allows estimates of performance to be obtained on the same scale even when the set of items taken by each individual is different. (For a description of IRT methodology, see, for example, De Ayala, 2009.)

B.4.2 Calibrations and Weights

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

B.4.2.1 Confirmation of calibration procedures

At each stage of the calibration, analyses were conducted at the Australian Council for Educational Research (ACER) and the results were then sent to the TEDS-M international study center at Michigan State University. Although the TEDS-M researchers at both institutions agreed on the details of the calibration (e.g., what items to include and exclude, how to treat missing data), the two centers conducted their analyses independently and then compared results. If results differed, the reasons were identified and the analyses repeated until agreement was reached.

B.4.3 Score Generation

Once calibration had been completed, TEDS-M used the item parameter estimates to estimate achievement for each respondent. In accordance with standard practice, items at the end of blocks without responses were considered as "not reached." TEDS-M treated these items as "missing" in the calibration but scored them as "incorrect" when estimating scores for individuals.

B.4.4 Standardization

The calibration data were used to carry out standardization. TEDS-M standardized the achievement estimates (in logits) to a mean of 500 and a standard deviation of 100, in line with the procedure followed in TIMSS, wherein all countries are weighted so that they 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, scores were computed for all participants for whom MCK and MPCK estimates could be obtained, including those participants not included in the final sample. The mean of 500 and the standard deviation of 100 thus apply to the calibration sample rather than to the complete set of scores. Exhibit B7 provides information about the assessment reliabilities.

Exhibit B.7: TEDS-M assessment reliabilities

		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
		Lower-Secondary MCK		
Sample	*Mean*	*Standard Deviation*	*Reliability*	*Standard Error of Measurement*
International	0.120	1.110	0.91	0.331
		Lower-Secondary MPCK		
Sample	*Mean*	*Standard Deviation*	*Reliability*	*Standard Error of Measurement*
International	0.087	1.223	0.72	0.644

B.4.5 Developing Anchor Points

The calibration results were also used to identify anchor points for the score scale. Anchor points are specific values on the score scale, each of which pertains to a description of what examinees at this point know and can do. TEDS-M identified two sets of test items to support development of the descriptions of the skills and knowledge at each anchor point.

The first set of test items contained those items that a person at that anchor point on the scale score would, according to the IRT model, be able to answer correctly with a probability of 0.70 or greater. The second set of test items included those items that a person at that anchor point on the scale score would, based on the IRT model, have a probability of 0.50 or less of answering correctly.

The anchor points selected were those for which there would be sufficient items of each type (between 10 and 12 items) to develop a description of the skills and knowledge that a person at that anchor point would have. Given these requirements, two anchor points were identified for the MCK primary scale and two for the MCK lower-secondary scale: 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 TEDS-M had fewer items measuring MPCK than MCK.

In order to develop descriptions of the capabilities of persons near each anchor point on the scales, committees of mathematicians and mathematics educators conducted detailed analyses of the sets of items for the respective anchor points. They did this work in workshops specifically set up for this purpose at the international research center at Michigan State University. The resulting anchor point descriptions give tangible meaning to points on the reporting score scales. They can be found in Chapter 6 of this report. A more detailed description is included in the TEDS-M technical report (Tatto, 2012).

B.5 Reporting Knowledge-Scale Scores

Although the mathematical content knowledge (MCK) measures (assessments) were different for the future primary teachers and the future lower-secondary teachers, and different from the mathematical pedagogical content knowledge (MPCK) measures, all were standardized in the same way. Readers unfamiliar with methodological detail may therefore consider findings generated by these measures comparable. In order to avoid the possibility of confusion, we report the findings pertaining to each scale separately, and none of our exhibits in this report lines up primary against secondary, or MCK against MPCK.

B.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 detailed the many ways in which the structure of teacher education programs differs across the 17 TEDS-M countries. It is clear from this report that, within the two populations of future teachers (primary and lower-secondary), there were substantial differences in the teaching roles for which the future teachers were being prepared.

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

In other IEA studies, such as TIMSS, for example, 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. TIMSS reports make clear that the samples chosen at each of these levels differ very little across countries with respect to their average age[4] and their years of schooling at the time of testing. When reporting TIMSS results, therefore, it makes sense to compare whole countries.

4 The definition given to grade level in TIMSS is actually designed to ensure that this is so.

While it is equally possible in TEDS-M to compare countries, the intent of the study has always been to conduct country comparisons only within the context of program-group. Nevertheless, when a country such as Chinese Taipei or the Russian Federation has only one program-type at the primary and one at the lower-secondary level, it is not possible to avoid whole-country rankings. But again, whole-country comparisons *per se* are not the key purpose of TEDS-M because they typically compare like with unlike. The presentation of TEDS-M results is directed, as far as possible, at comparing like with like—in this case, teachers who are being prepared to undertake similar roles once they qualify.

B.5.2 Program-Groups

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. Exhibits B.8 and B.9 show how these program-groups differ from one country to another.

The two exhibits present clearly identifiable program-groups—four at the primary level and two at the secondary level. These are, as annotated on the tables:

- *Future primary teacher groups:*
  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 groupings were used as the basis for reporting MCK and MPCK score summaries. The summaries presented in this report and elsewhere include:

- Tables of means, standard deviations, and standard errors, by program-groups and by country, and indicating the number of cases and percent of missing cases. In these tables, the standard errors are calculated as described in Section B.3.2 of this report. The IDB analyzer was used for these calculations.
- Standard box-plots, used to portray whole distributions and presenting the median, the 25th and 75th percentiles, and the range (excluding outliers). In the exhibits, overlay lines on the box-plots indicate the anchor points on the score scales.

Exhibit B.8: Program-types and groupings: future primary teachers

Program-Group	Country	Programs	Number of Respondents	Grade Span
Program-Type 1. Lower Primary (to Grade 4 Maximum)	Georgia	Bachelor in Pedagogy *(4 years)*	485	1–4
		Bachelor in Pedagogy *(5 years)*	21	1–4
	Germany	Teachers for Grades 1-4 with Mathematics as Teaching Subject (Type 1A)	360	1–4
		Teachers for Grades 1-4 without Mathematics as Teaching Subject (Type 1B)	162	1–4
		Teachers for Grades 1-10 without Mathematics as Teaching Subject (Type 2B)	413	1–4
	Poland	Bachelor of Pedagogy Integrated Teaching, first cycle *(full-time programs); Years: 3*	510	1–3
		Master of Arts Integrated Teaching, long cycle *(full-time programs); Years: 5*	268	1–3
		Bachelor of Pedagogy Integrated Teaching, first cycle *(part-time programs); Years: 3*	828	1–3
		Master of Arts Integrated Teaching, long cycle *(part-time programs); Years: 5*	206	1–3
	Russian Federation	Primary Teacher Education	2,266	1–4
	Switzerland (German-speaking parts)	Teachers for Grades 1-2/3 *(Kindergarten and Grades 1–2)*	75	1–2/3
		Teachers for Grades 1-2/3 *(Kindergarten and Grade 1–3)*	46	1–2/3
Program-Type 2. Primary (to Grade 6 Maximum)	Chinese Taipei	Elementary Teacher Education	923	1–6
	Philippines	Bachelor in Elementary Education	592	1–6
	Singapore	Diploma of Education, Primary Option C	107	1–6
		Bachelor of Arts in Education, Primary	31	1–6
		Bachelor of Science in Education, Primary	36	1–6
		Post-Graduate Diploma in Education, Primary Option C	89	1–6
	Spain (Primary Education Only)	Teacher of Primary Education	1,093	1–6
	Switzerland (German-Speaking Parts)	Teachers for Primary School (Grades 1-6) *(Kindergarten and Grades 1–6)*	235	1–6
		Teachers for Primary School (Grades 1-6)	556	1–6
		Teachers for Primary School (Grades 3-6)	24	3–6
	United States (Public Instiutions)	Primary Concurrent	1,137	1–3/4/5
		Primary Consecutive	173	1–3/4/5

Exhibit B.8: Program-types and groupings: future primary teachers (contd.)

Program-Group	Country	Programs	Number of Respondents	Grade Span
Program-Type 3. Primary/Lower Secondary (to Grade 4 Maximum	Botswana	Diploma in Primary Education	86	1–7
	Chile	Generalist	657	1–8
	Norway	General Teacher Education (ALU) without Mathematics Option	392	1–10
		General Teacher Education (ALU) with Mathematics Option	159	1–10
Program-Type 4. Primary Mathematics Specialists	Germany	Teachers of Grades 1-9/10 with Mathematics as Teaching Subject (Type 2A)	97	1–9/10
	Malaysia	Malaysian Diploma of Teaching (Mathematics)	512	1–6
		Bachelor of Education, Primary	17	1–6
		Diploma of Education (Mathematics)	47	1–6
	Poland	Bachelor of Arts in Mathematics, first cycle *(full-time teacher education programs); Years: 3*	134	4–9
		Master of Arts in Mathematics, long cycle *(full-time teacher education programs); Years: 5*	123	4–12
		Bachelor of Arts in Mathematics, first cycle *(part-time teacher education programs); Years: 3*	20	4–9
		Master of Arts in Mathematics, long cycle *(part-time teacher education programs); Years: 5*	23	4–12
	Singapore	Diploma of Education, Primary Option A	45	1–6
		Post-Graduate Diploma in Education, Primary Option A	72	1–6
	Thailand	Bachelor of Education	599	1–12
		Graduate Diploma in Teaching Profession	61	1–12
	United States (Public Institutions)	Primary + Secondary Concurrent	184	4/5–8/9
		Primary + Secondary Consecutive	7	4/5–8/9

Exhibit B.9: Program types and groupings: future secondary teachers

Program-Group	Country	Programs	Number of Respondents	Grade Span
Program Type 5: Lower-Secondary (to Grade 10 Maximum)	Botswana	Diploma in Secondary Education, Colleges of Education	34	8–10
	Chile	Generalist	648	1–8
		Generalist with further mathematics education	98	5–8
	Germany	Teachers of Grades 1–9/10 with Mathematics as Teaching Subject (Type 2A)	87	1–9/10
		Teachers for Grades 5/7–9/10 with Mathematics as Teaching Subject (Type 3)	321	5/7–9/10
	Norway	General Teacher Education (ALU) without Mathematics Option	356	1–10
		General Teacher Education (ALU) with Mathematics Option	151	1–10
	Philippines	Bachelor in Secondary Education	733	7–10
	Poland	Bachelor of Arts in Mathematics, first cycle *(full-time teacher education programs); Years: 3*	135	4–9
		Bachelor of Arts in Mathematics, first cycle *(part-time teacher education programs); Years: 3*	23	4–9
	Singapore	Post-Graduate Diploma in Education, Lower Secondary, *January 2007 intake*	50	7–8
		Post-Graduate Diploma in Education, Lower Secondary, *July 2007 intake*	92	7–8
	Switzerland (German-Speaking Parts)	Teachers for Secondary School (Grades 7-9)	141	7–9
	United States	Primary + Secondary Concurrent	161	4/5–8/9
	(Public Institutions)	Primary + Secondary Consecutive	8	4/5–8/9

Exhibit B.9: Program types and groupings: future secondary teachers (contd.)

Program-Group	Country	Programs	Number of Respondents	Grade Span
Program-Type 6. Upper Secondary (to Grade 11 and above)	Botswana	Bachelor of Secondary Education (Science), University of Botswana	19	8–12
	Chinese Taipei	Secondary Mathematics Teacher Education	365	7–12
	Georgia	Bachelor of Arts in Mathematics	69	5–12
		Master of Science in Mathematics	9	5–12
	Germany	Teachers for Grades 5/7–12/13 with Mathematics as a Teaching Subject (Type 4)	363	5/7–12/13
	Malaysia	Bachelor of Education (Mathematics), Secondary	43	7–13
		Bachelor of Science in Education (Mathematics), Secondary	346	7–13
	Norway	Teacher Education Program (PPU)	43	8–13
		Master of Science	22	8–13
	Oman	Bachelor of Education, University	30	5–12
		Educational Diploma after Bachelor of Science	16	5–12
		Bachelor of Education, Colleges of Education	222	5–12
	Poland	Master of Arts in Mathematics, long cycle *(full-time teacher education programs); Years: 5*	122	4–12
		Master of Arts in Mathematics, long cycle *(part-time teacher education programs); Years: 5*	18	4–12
	Russian Federation	Teacher of Mathematics	2,141	5–11
	Singapore	Post-Graduate Diploma in Education, *Secondary, January 2007 intake*	105	7–12
		Post-Graduate Diploma in Education, *Secondary, July 2007 intake*	146	7–12
	Thailand	Bachelor of Education	595	1 – 12
		Graduate Diploma in Teaching Profession	56	1 – 12
	United States (Public Institutions)	Secondary Concurrent	356	6/7 – 12
		Secondary Consecutive	82	6/7 – 12

B.6 Methods Used to Determine the Opportunity to Learn and Beliefs Scales and Reporting

B.6.1 Opportunity to Learn Measures

Opportunity to learn (OTL) measures were based on scales and items developed in a variety of ways. Several were based on previous research conducted at Michigan State University and elsewhere. Some were based on previous research conducted at the Australian Council for Educational Research (ACER), and some were developed specifically for TEDS-M, in collaborative workshops and meetings which included the researchers in the international research centers at Michigan State University and ACER, and in the national research centers in the participating countries.

After completing an extensive pilot of a larger set of items, TEDS-M researchers 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.

The researchers then conducted a confirmatory factor analysis (described more fully below) that was based on a preconceived conceptualization of OTL as encompassing four broad categories relating to mathematics content areas: tertiary and school-level mathematics, mathematics education pedagogy, general education pedagogy, and school-based experiences. The aim of the analysis was to assess the fit of each OTL index (measure) to the data and the index interrelations. Each of the four broad categories contained several indices, which taken together across the categories resulted in 24 individual, distinct OTL indices.

Using as their reference the best-fitting models, the researchers then created OTL index scores. The OTL indices for topics studied (mathematics content, mathematics pedagogy, and general pedagogy) were derived from summing the number of topics studied. Rasch logit scores were estimated for the OTL indices using rating scales (e.g., activities in which future teachers participated from "never" to "often"). These scores (described more fully below) were centered at the point on the OTL scale that is associated with the middle of the rating scale (essentially "neutral"). More explicitly, this step involved using the test characteristic curve to identify the point on the θ-scale associated with the midpoint on the summed score scale. The θ-value was used to center the OTL scale so that it would be located at a scaled value of 10.

All OTL scales consisting of *number of topics* are interpretable given the number of topics within each scale; the research team used mean proportions to report outcomes in terms of number of topics studied for each OTL index (for instance, a mean proportion of .52 would indicate that about half of the future teachers reported studying a given topic).

All OTL scales based on *Rasch logit* scores can be interpreted given the location of the mid-point, where 10 is associated with the "neutral" position. Thus, for example, the median score on the scale *teaching for diversity* in a given program is 12.2, indicating a moderately high level of OTL.

Exhibit B.10: Opportunity to learn indices

OTL Index Label	Primary and Secondary Indices			Teacher Educator Indices		
	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		F, G, H, I, P, S	MFB1DISC	None		
Tertiary-Level Mathematics–continuity and functions		J, K, L, M, N	MFB1CONT	None		
Tertiary-Level Mathematics–probability and statistics		Q, R	MFB1PRST	None		
School-Level Mathematics–numbers, measurement, geometry	Q2	A–C	MFB2SLMN	None		
School-Level Mathematics—functions, probability, calculus		D–G	MFB2SLMF	None		
Mathematics Education pedagogy—foundations	Q4	A–C	MFB4FOUN	None		
Mathematics Education Pedagogy—instruction		D–H	MFB4INST	None		
Mathematics Ed Pedagogy—class participation	Q5	B–F	MFB5PART	I1	B-F	MEI1PART
Mathematics Ed Pedagogy—class reading		H–K	MFB5READ	I1	H-K	MEI1READ
Mathematics Ed Pedagogy—solving problems		L–O	MFB5SOLV	I1	L-O	MEI5SOLV
Mathematics Ed Pedagogy—instructional practice	Q6	L, N, Q, R, T, Z	MFB6IPRA	G2	C, E-I	MEG2IPRA
Mathematics Ed Pedagogy—instructional planning		A, G–K, X	MFB6IPLA	I3	A, E-I, P	MEI3IPLA
Mathematics Ed Pedagogy—assessment uses	Q6	O, P, U, V, W	MFB6AUSE	I3	J, K, M-O	MEI3AUSE
Mathematics Ed Pedagogy—assessment practice		B–F	MFB6APRA	G2 I3	A-B C-D	MEG2APRA
Education Pedagogy—social science	Q7	A–C	MFB7EPSS	None		
Education Pedagogy—application		D–H	MFB7EPAP	None		
Teaching for Diversity	Q8	A–F	MFB8DVRS	H2	A-F	MEH2DVRS
Teaching for Reflection on Practice	Q89	8G–J	MFB8REFL	H2	G-J	MEH2REFL
Teaching for Improving Practice		9E–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		F–I	MFB14STF	None		
Program Coherence	Q15	A–F	MFB15COH	J1	A-F	MEJ1COH

B.6.2 Opportunity to Learn Scale Development

B.6.2.1 Initial development and item selection

The development of OTL indices began at the beginning of the TEDS-M project, with TEDS-M researchers using information from previous research, including Pre-TEDS, ACER, and related OTL research (Papanastasiou & Tatto, 2011; Richardson, Shields, & Tatto, 2001; Tatto, 1996, 1998, 1999, 2001a, 2001b: Tatto & Papanastasiou, 2002). Several of the indices, such as *connecting theories of teaching and learning* and *connecting practice and reflection*, had been developed and used successfully in previous ACER-conducted research. Prior evidence regarding the effectiveness and usefulness of such information was gathered when the TEDS-M pilot instruments were developed. These connections to prior research and theory provide strong validity-related evidence regarding the content of the OTL scales as well as their meaningfulness and appropriateness.

B.6.2.2 Analysis of pilot item data

TEDS-M pilot results were analyzed with reference to the project's conceptual framework, previous research and evidence, and the TEDS-M pilot data. The TEDS-M team conducted several levels of exploratory and confirmatory analyses on the pilot responses to all OTL items. The team then used the comprehensive analyses of OTL item response data to select the final OTL items for inclusion in the operational surveys. The comprehensive analyses of pilot results and the consistency in OTL index structures made evident through prior research provide validity-related evidence regarding the construct definitions of OTL for future teachers.

B.6.2.3 Initial analysis of operational survey results

The initial analyses of these results employed exploratory methods, including factor analysis, scale reliability analyses, and some limited Rasch scaling. Results were remarkably similar to the pilot findings, and there was strong consistency between the future primary teacher and future lower-secondary teacher results. These initial commonalities suggest successful identification of OTL indices, particularly in light of the consistency with pilot results and their connections to previous research.

B.6.2.4 Validity evidence for OTL indices

Each of the OTL indices was analyzed for psychometric quality, including the provision of internal-consistency evidence, score reliability evidence, and (in particular) evidence of measurement invariance. These methods were primarily based on confirmatory models—models that are appropriate given the nature of the data.

B.6.2.5 Confirmatory factor analysis

Confirmatory factor analysis (CFA) provided strong construct-related evidence regarding the factor structure of each OTL index. It was imperative for the TEDS-M team to establish the independence of each measure of OTL in order to provide clear information about independent explanatory variables that could potentially explain variation in important outcomes of teacher preparation. CFA enables testing of data-model fit and provides a means of assessing the usefulness of simpler versus more complex factor structures. The goal in this approach is to identify the most parsimonious set of OTL indices.

To complete the CFA for each set of OTL measures, the TEDS-M researchers used the statistical software package Mplus 5.2. The data analysis was done at the teacher level, using final teacher weights. The factor structure, based on factors expected from previous research and pilot results, were initially assessed across countries. To assess the degree to which these factor structures were invariant across countries, the research team used multiple group confirmatory factor analysis (MCFA). This type of analysis allowed the team to test the fit of a given factor structure in each country. The test was an important one in terms of defending the meaningfulness of each OTL index within and across countries. Mplus MCFA has particular features that made it a strong application for TEDS-M, namely accommodation of missing data, the utility of handling complex survey data, and opportunity to conduct single- or multiple-group analyses.

Mplus also allows for non-normal continuous factor indicators, which TEDS-M employed when analyzing the OTL indices from the future teacher survey. Some TEDS-M OTL indices were based on topics studied, for example, the tertiary-level mathematics topics. The responses from these indicators include studied/never studied, resulting in dichotomous responses (0/1).

The remaining OTL indices were based on ordinal indicators on a four-point scale (either "never" to "often," or "disagree" to "agree"). Mplus furthermore allows for proper CFA estimation with 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.

Finally, Mplus was used to conduct a second-order factor analysis. This step involved an examination of the combined structures of the entire set of OTL indices, which could also be tested via MCFA across countries.

B.6.2.6 Rasch scaling

The TEDS-M team used Rasch scaling to produce the reporting score scale for the OTL indices. Rasch scaling provides measures of OTL that have several scale (statistical) properties which make them stronger variables in general linear model (GLM-based) analyses. When the assumptions of the model are met, Rasch scales approximate interval-level measurement, providing a scale with properties suited for 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. The Rasch analysis locates each indicator on the same scale as that for person-trait levels, thereby providing for a meaningful ordering of indicators relaying information about the rarity or severity of each indicator (a form of item difficulty). Rasch scaling provides an efficient way to estimate trait values for individuals who have not responded to every item. It also makes it possible to conduct weighted analyses when estimating item locations on the trait scale.

To complete the scaling, the TEDS-M researchers scaled the OTL indices independently, using a combined file of primary and future lower-secondary teachers across countries. Only those cases that responded to more than 50% of the items were included in the scaling. Future teacher weights were recomputed for each OTL index. This step accounted for the variation in the resulting sample based on the inclusion criteria (response to more than 50% of the items within a scale) resulting from each scale responded to by a different proportion of respondents within each country.

TEDS-M researchers next adjusted the weights again so that they summed to 500 for each country for primary and lower-secondary separately. Thus, each country with primary and lower secondary respondents contributed 500 primary and 500 lower-secondary units of observations to the final scaling. The weights were estimated using a simple transformation based on resulting sample size and effective sum of 500 for each population in each country. This first level of analysis with valid cases constituted the calibration sample.

Winsteps, with the partial-credit model, was used to estimate the Rasch item calibrations. This procedure allowed each item to contribute different threshold values for each rating-scale point. The calibration values were then used to provide scores for all cases responding to more than 50% of the items, regardless of validity status. This was done in order to provide scores for all cases, even those excluded as an outcome of sample adjudication. This approach meant that countries with cases not included could conduct, if they deemed it meaningful to do so, full analyses of all their cases.

Several OTL indices were also available in the educator data. The item parameters calibrated from future teachers were used as fixed parameters to estimate scale scores for educators, thereby placing the OTL scale scores from educators on the same scale as that for future teachers and thus facilitating comparative inferences. Information about the fit of the OTL measures with the educator responses, as estimated by MPlus through a confirmatory factor analysis process (described above), is available in the technical report (Tatto, in press).

B.6.2.7 Identification of the OTL indices

Exhibit B.10 presents the indices of OTL identified. The technical report (Tatto, 2012) contains additional tables with detailed information about model fit.

B.6.3 Development, Scaling, and Scoring of Beliefs Scales

The belief scales were based on items from research-based belief scales used in earlier studies already cited in the OTL section. On completion of the extensive pilot, TEDS-M researchers selected items from those that had survived the exploratory factor analyses. They also selected a subset of highly homogeneous items per scale for the operational forms. The next step was to evaluate the effectiveness of the six-point rating scale (used for some belief scales). The additional Rasch rating-scale analyses conducted for this stage supported continued use of the six-point scale. The complete analytical process mirrored that used for the OTL scales, as described above.

Using as their reference point 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 they were centered at the point on the scale that is associated with the middle of the rating scale (essentially “neutral”). All belief scales were therefore based on a score scale where 10 was located at the neutral position. The same process used for the OTL indices that were based on the rating-scale items was used for the beliefs scales.

B.6.3.1 Identification of beliefs indices

Exhibit B.11 sets out the beliefs indices identified for TEDS-M. The technical report (Tatto, 2012) contains additional tables with detailed information about the model fit of these indices.

Exhibit B.11: Beliefs indices

Beliefs Index Label	Primary and Secondary Indices			Teacher Educator Indices		
	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		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
Program Effectiveness	D5	A–F	MFD5PROG	None		

References

De Ayala, R. J. (2009). *The theory and practice of item response theory*. New York: The Guilford Press.

Fay, R. E. (1989). Theoretical application of weighting for variance calculation. In *Proceedings of the Section on Survey Research Methods of the American Statistical Association* (pp. 212–217). Alexandria, VA: American Statistical Association.

Lohr, L. S. (1999). *Sampling: Design and analysis*. Pacific Grove, CA: Duxbury Press.

Masters, G. (1982). A Rasch model for partial credit scoring. *Psychometrika*, *47*, 149–174.

McCarthy P. (1966). Replication: An approach to the analysis of data from complex surveys. In *Vital and Health Statistics* (Series 2, No. 14). Hyatsville, MD: National Center for Health Statistics.

Papanastasiou, E. C., & Tatto, M. T. (2011). Program theory, program documents, and state standards in evaluating teacher education. *Assessment and Evaluation in Higher Education*, *36*, 1–16.

Rasch, G. (1980). *Probabilistic models for some intelligence and attainment tests*. Chicago, IL: University of Chicago Press (originally published 1960).

Richardson, V., Shields, P., & Tatto, M. T. (2001, March). *Alternative assessments of teaching and teacher education*. Forum presentation at at the annual conference of the American Association of Colleges of Teacher Education, Dallas, TX.

Tatto, M. T. (1996). Examining values and beliefs about teaching diverse students: Understanding the challenges for teacher education. *Educational Evaluation and Policy Analysis*, *18*(2), 155–180.

Tatto, M. T. (1998). The influence of teacher education on teachers' beliefs about purposes of education, roles, and practice. *Journal of Teacher Education*, *49*(1), 66–77.

Tatto, M. T. (1999). The socializing influence of normative cohesive teacher education on teachers' beliefs about instructional choice. *Teachers and Teaching*, *5*(1), 111–134.

Tatto, M.T. (2001a, March). *Evaluating the teacher preparation program at Michigan State University: Challenges involved in testing the theory of teacher preparation and of current accreditation guidelines*. Paper presented at the annual conference of the American Association of Colleges of Teacher Education, Dallas, Texas, United States.

Tatto, M. T. (2001b, April). *Evaluating the teacher preparation program at Michigan State University: Some reflections and preliminary results*. Paper presented at the annual meeting of the American Education Research Association, Seattle, Washington, United States.

Tatto, M. T. (2012). *The Teacher Education Study in Mathematics (TEDS-M) technical report*. Amsterdam, the Netherlands: International Association for the Evaluation of Educational Achievement (IEA) and Springer.

Tatto, M. T., & Papanastasiou, E. (2002, April). *Developing long-term systemic inquiry in teacher education programs: Challenges involved in testing the theory of teacher education programs and of current accreditation guidelines*. Paper presented at the annual meeting of the American Education Research Association, New Orleans, Louisiana, United States.

Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). *Teacher Education Study in Mathematics (TEDS-M): Conceptual framework*. Amsterdam, the Netherlands: International Association for Educational Achievement (IEA).

UNESCO. (1997). *ISCED levels*. Retrieved from http://www.unesco.org/education/ information/ nfsunesco/doc/isced_1997.htm

Wu, M., Adams, R., Wilson, M., & Haldane, S. (2007). *ACER Conquest: Generalised item response modelling software (Version 2.0)*. Melbourne, Victoria, Australia: Australian Council for Educational Research (ACER).

APPENDIX C:

ORGANIZATIONS AND INDIVIDUALS RESPONSIBLE FOR TEDS-M

C.1 Introduction

TEDS-M is the result of scholars and institutions working in collaboration in order to study the mathematics preparation of future primary and lower-secondary teachers. The study's success is due to the extraordinary work and competence of a great many people. The key contributors among this group are listed below.

Credit is due to the country national research centers, to the coordinators of the teacher education programs in the TEDS-M samples, and to the future teachers and teacher educators who made the collection of data possible. All potential respondents were free to refuse to answer our questionnaires. The willingness of so many future teachers and teacher educators to participate was therefore very gratifying, and even more so given that participation for the future teachers meant agreeing to take a test of mathematics content and mathematics pedagogy knowledge.

The participating countries were Botswana, Canada, Chile, Chinese Taipei, Georgia, Germany, Malaysia, Norway, Oman, the Philippines, Poland, the Russian Federation, Singapore, Spain, Switzerland, Thailand, and the United States of America. The commitment of these countries to participate in and overcome the many challenges of implementing a study of such magnitude as TEDS-M has made it possible to envisage a rich future of cross-national research on teacher education.

C.2 TEDS-M Management and Coordination

TEDS-M was conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA). The College of Education at Michigan State University (MSU) and the Australian Council of Educational Research (ACER) were appointed by IEA as the joint international study centers (ISCs) for TEDS-M under the executive direction of Maria Teresa Tatto of MSU. To design and carry out the study, the ISCs worked in collaboration with the IEA Data Processing and Research Center (DPC) in Hamburg, the IEA Secretariat in Amsterdam, Statistics Canada, and the TEDS-M national research centers in the 17 participating countries. Together, these teams of researchers and institutions conceptualized the study, designed and administered the instruments, collected and analyzed the data, and reported the results.

The TEDS-M ISC at Michigan State University worked closely with ACER and the IEA Secretariat in Amsterdam, which provided overall guidance, and was responsible for verification of translations of the survey instruments produced by the participating countries and quality control of data collection.

The IEA DPC worked with the TEDS-M international center at MSU to prepare the manuals guiding the collection of data, and with both ISCs in all other aspects of data verification. The DPC was also responsible for data processing and verifying the internal consistency and accuracy of the data submitted by the participants. They were furthermore responsible for developing the TEDS-M database that will be publicly available for secondary analysis by researchers worldwide.

The sampling unit of the IEA DPC in collaboration with the ISC at MSU was responsible for the innovative sampling design that produced nationally representative samples of teacher education institutions, future primary and lower-secondary teachers, and teacher educators. We thank Statistics Canada for serving as the sampling referee. Michigan State University in collaboration with ACER and the University of Minnesota provided expertise on the application of psychometric methods and on data calibration and scaling of the opportunity to learn, beliefs, and knowledge-assessment data. We are thankful to Eugene Gonzales of the IEA DPC for his contribution to the data calibration and scaling process.

The TEDS-M management team met twice a year throughout the study to discuss progress, procedures, and schedule. In addition, the directors of the TEDS-M ISCs met with members of IEA's technical executive group twice yearly to review technical issues.

Maria Teresa Tatto from Michigan State University was the principal investigator, the executive director of TEDS-M, and chair of the TEDS-M management team. The study co-directors were John Schwille and Sharon Senk at the ISC at MSU. Lawrence Ingvarson, Glenn Rowley, and Ray Peck co-directed the study center at ACER.

Sharon Senk, Kiril Bankov, and Ray Peck served as the TEDS-M mathematics coordinators. Maria Teresa Tatto and Michael Rodriguez were responsible for the background questionnaires, coordinated the opportunity to learn study, and, together with Glenn Rowley, the beliefs study. Maria Teresa Tatto and Jack Schwille coordinated the institution /program study. Jack Schwille, Lawrence Ingvarson, and Maria Teresa Tatto coordinated the policy study.

Development of the overall study methods and instruments was led by Maria Teresa Tatto, Glenn Rowley, Michael Rodriguez, Mark Reckase, and Kiril Bankov. Sabine Meinck from the IEA DPC developed the sampling frame and worked with the national research centers to implement each country's sample design. Jean Dumais from Statistics Canada served as the sampling referee. Ralph Carstens and Falk Brese from the IEA DPC were responsible for producing the manuals guiding data collection and entry and for developing the TEDS-M international database.

TEDS-M frequently brought together panels of internationally recognized experts in mathematics and mathematics education, research, curriculum, instruction, and assessment; their advice and review were critical to the credibility of the study and the results achieved. Their names and institutions are listed below.

In order to expedite work with the international team and coordinate within-country activities, each participating country designated one or more individuals to be the TEDS-M national research coordinator or NRC. The NRCs had the complicated and challenging task of advising the international design team as well as implementing TEDS-M in their countries in accordance with international guidelines and procedures. The quality of the TEDS-M assessment and other data depended on the NRCs and their colleagues carefully carrying out the very complex sampling, data collection, and scoring tasks involved. Their names and affiliations are listed below.

TEDS-M benefited from the six-country developmental study, which was co-directed by William Schmidt and Maria Teresa Tatto and funded by the National Science Foundation (USA). This developmental study informed the design and instruments

used in TEDS-M. The participating countries were Bulgaria, Germany, Korea, Mexico, Taiwan, and the United States.

C.3 Technical and Editorial Advice

Throughout TEDS-M, the writing and publishing of the various reports associated with it benefited from the careful reviews of the IEA technical executive committee, comprising Hans Wagemaker (chair), Jan Eric Gustafson, Larry Hedges, Marc Joncas, Mick Martin, Ina Mullis, Heiko Sibberns, and Norman Verhelst. The IEA publications committee provided excellent editorial feedback; special thanks go to David Robitaille and Bob Garden.

C.4 Funding

TEDS-M was made possible through a generous grant to Michigan State University from the National Science Foundation (REC 0514431). Additional support came from countries' IEA participation fees and from IEA's own financial reserves. This financial support is gratefully acknowledged as critical to the successful completion of this study. In addition, we gratefully acknowledge our program officer at the National Science Foundation, James Dietz, and the executive director of IEA, Hans Wagemaker, for their clear vision and unwavering support throughout the study.

Any opinions, findings, and conclusions or recommendations expressed in this report are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

C.5 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

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 (co-NRC)	National Taiwan Normal University, Department of Mathematics National Hsinchu University of Education, Graduate Institute of Mathematics and Science Education
Georgia	Maia Miminoshvili Tamar Bokuchava	National Assesment 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 (IPST)
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

The Teacher Education and Development Study (TEDS-M) is the first cross-national study to use representative samples in order to examine the preparation of future teachers of mathematics at both the primary and secondary school levels. The study was conducted under the auspices of the International Association for the Evaluation of Educational Achievement (IEA).

In its 54 years of 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. TEDS-M is the first IEA project to focus on tertiary education and to pay particular attention to teachers and their learning.

Seventeen countries participated in TEDS-M. 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. Altogether, close to 5,000 mathematicians, mathematics educators, and general pedagogy educators participated in TEDS-M.

The key research questions for the study focused on the associations between teacher education policies, institutional practices, and future teachers' knowledge (by the end of their preservice education) of mathematics and pedagogy. This report describes and compares national policies relating to teacher education and documents how the participating countries organize their teacher education provision. The report provides insight not only into the main characteristics of the various tertiary-education programs and their curricula, but also into the opportunities to learn about mathematics and mathematics pedagogy that the programs offer their future teachers.

The findings of assessments of the participating future teachers' mathematics content knowledge and mathematics pedagogy knowledge are presented within this context, as are the results of surveys on the teachers' beliefs about mathematics and learning mathematics. The report also provides information on various characteristics of programs' teacher educators in the participating countries.

The TEDS-M results provide evidence that may be used to improve policy and practice relating to preparing teachers of mathematics. It also provides a new baseline for future research on teacher education and development.

This report is the third publication to emerge from TEDS-M. It was preceded by a report documenting the study's conceptual framework and a report that considered teacher salaries within the scope of student achievement. Future publications include a detailed report on the contexts in which teacher education takes place, an encyclopedia presenting country by country TEDS-M information, and a technical report. IEA will also make available an international database of TEDS-M findings that the wider research community can use in order to conduct secondary analyses.