Chapter 1.1.1
Overview of Teacher Education Systems Across the World

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From a system as well as from an institutional perspective, the education of teachers is dependent on the occurrence of a number of interconnected events which are in turn closely related with the life cycle of teachers' careers: entry to teacher education signals the beginning of teachers' careers, and it comes accompanied by recruitment and selection processes and by individual expectations among those choosing to become teachers. The knowledge acquired during teacher education is expected to transfer into knowledge for teaching and, presumably, on improved pupil learning. In all instances teacher education evolves within and interacts with social, economic, and political contexts.

The following text is based on two sources: contributions to the plenary panel at the 15th study conference, coordinated by M. T. Tatto (panelists J. Novotná, D. Tirosh, and R. Spanneberg), "Framing the questions: Understanding mathematics teacher education cross-nationally"; and individual descriptions of mathematics pre-service teacher-training systems delivered by Strand I participants and summarized by S. Lerman.[1] National contributions to this overview are listed in the references but not within the text.

The characterization of teacher education systems across the world and the opportunities they provide teachers in learning about mathematics is shaped by the following components:

- the entry to the profession (e.g., characteristics of future teachers and what they bring with them);
- the processes of learning to teach (e.g., the structure and approach followed by teacher education programmes and the programmes' curricular sequence); and
- the outcomes of such learning experiences (e.g., the knowledge teachers acquire, including the approaches they learn to teach).

[1] Particular characteristics of the teacher education systems summarized in this chapter will be published as an article in a specialized research journal.

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The text is framed by the following questions describing the framework of the 15th study conference plenary panel:

- What are the system characteristics?
- What are the institutional characteristics? (Who goes into teaching? Who are the teacher educators? What is in a credential? What is in the curriculum?)
- What are the structure and approaches to teacher education? (What is the overall structure of the curriculum? What content goes into the teacher education curriculum? What are the links between theory and practice?)

1. System Characteristics

Current trends in teacher education reform reflect a need for unification (e.g., in the European Union the Bologna Declaration) as well as a need to attend to local demands as a response to compete in a global economy (see Tatto, 2007a, b). The response to these pressures is diverse. Whereas in some country contexts the need to compete in the economy has prompted teacher education programmes to add more years and to provide deeper content knowledge, thus relocating teacher preparation in universities, in others the trend is towards more emphasis on training on the job. A review of the materials provided by the ICMI data illustrates the diverse trends.

Among the twenty country regions[2] meeting at the study conference, many reported the universities as the major context for teacher education. Whereas in some country contexts this has been a long-standing tradition (e.g., Germany), others, such as South Africa, have just recently moved in this direction. In other country contexts teacher education is located in national teacher colleges or it represents a combination of both, education in universities and in teacher colleges (e.g., pedagogical institutes for elementary teachers). England's teacher education presents the most diversity, as it is located both in universities and in schools and it also permits a number of variations, including an examination-only option. Uganda covers the most range by including education in universities, local and national teacher colleges, and schools, and in-service education is offered via the distance education model.

Another important characteristic of contemporary teacher education is its level of regulation. Most of the ICMI participants reported some kind of regulation at the national level (usually via ministries of education) and state or local levels (via local ministries). In sum there seems to be a trend towards increased regulation whether located at the national or at the local levels. The United Kingdom and France illustrate a strong regulatory and centralized system.

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[2] We refer here to country regions or contexts rather than full countries, as ICMI participants reported that in some cases data on this and in other aspects of teacher education is not available nationally; thus, the information we have available represents the best approximation to what we know at this point. Readers should note that the data was collected in mid-2005 and some changes may have occurred.

Systemic change in teacher education is enacted in institutions, including teacher education programmes and schools. In the following section we explore in broad strokes how the institutions offering teacher education are organized across different settings. Questions of interest relate to recruitment and selection, the structure of teacher education programmes, the content of the curriculum, and the credentials obtained.

2. Institutional Characteristics

From an institutional perspective, entry to teacher education may or may not be selective, but even when entry is non-restrictive, personal choices (or self-selection) are at work. Who enters the profession is not only determined by institutional selection policies and programme requirements, but also by the personal choices individuals make regarding the programmes they enter and the courses they take. Institutions that deliberately recruit and select future teachers may be assumed to use rationales based on "what works" locally or globally. Relevant characteristics, such as entry-level qualifications, years of study, years of tertiary schooling, and years of experience, gender, and age have been considered to be predictors of effective teaching practices and pupil achievement in studies on school effects on mathematics knowledge in several countries. There is great variability in the kinds of requirements, length, and quality of professional education offered to teachers across contexts. Most participants reported that entry level to the profession occurs after secondary education, with various entry-level selectivity criteria.

Intrinsically linked to structural characteristics, teacher educators can be seen as most important in shaping the teacher education curriculum. Those teaching teachers are differentiated according to their institutional departments and disciplines. Thus for the most part mathematicians teach mathematics courses, and in some cases these are taught by mathematics educators who may have a mathematics degree as well. For the most part pedagogy courses are taught by educators or in some cases mathematics educators who may have backgrounds in psychology, sociology, or philosophy or may be experienced teachers. Practicum is for the most part supervised by practicing teachers and teacher educators.

Another important characteristic of teacher education institutions is the awarding of credentials and the point in teachers' lifecycles when this occurs. The information gathered via the ICMI participants as well as from the international literature signals a growing trend to award credentials to teachers at least at the first stage of tertiary education. In some cases mathematics teachers teaching higher levels hold credentials at the second level of tertiary education. As previously discussed, as important as the credential is, it provides limited information regarding the level of knowledge attained by teachers and whether such knowledge provides the basis for effective teaching. Understanding what constitutes a credential amounts to looking into the "black box" of teacher education and into the opportunities to learn designed to support teacher knowledge. Again we resort to the international literature to uncover these connections. Most prospective mathematics teachers reach the first

stage of tertiary education (International Standard Classification of Education, 1997, ISCED 5A). Others obtain the second stage of tertiary education, leading to an advanced research qualification (ISCED 6), as some countries seem to require a full master's qualification before entering the profession.

3. Structure and Approaches to Teacher Education

Teacher education characteristics (e.g., programme structure) and approach or orientation (e.g., curricular content and sequence, pedagogy) importantly shape opportunities to learn and may influence teachers' knowledge, practice, and presumably pupil learning. The information obtained at the study conference shows great variability among the options offered future mathematics teachers. Nevertheless, pre-service teacher education can be generally understood as concurrent (bringing together general education and pedagogy plus teaching practice and/or practicum); consecutive (general preparation occurs independently of teacher education and also includes teaching practice and/or practicum). In-service preparation may include any of the options described previously.

For the purposes of this report, *concurrent preparation* is defined as the joint occurrence of general education and professional education in a single programme. In addition this definition includes varying periods of field-based practice or practicum. In the case of the 15th study conference, programmes included preparation on the mathematics content and pedagogy and varied lengths of field experience or practicum. The length of all these periods was quite variable, and for the most part the period for both mathematics and pedagogy preparation ranged from three to six years, and the period of practice also varied from eighty days to a year.

For the purposes of this report *consecutive preparation* consists of an independent period of general education and a separate period of teacher preparation, to which a varying period of practice may follow. In the case of the 15th study conference reports, the length of programmes varied from two to five years of general education (e.g., in mathematics) and from one to four years of teacher preparation. Periods of practice ranged from forty-five days to two years.

An important part of the curriculum sequence and delivery can be found on the teaching practice and practicum components. There is great variability in this area, with some programmes providing only limited practice and others providing extensive periods of partially independent practice. Still, a further question concerns the curriculum emphasis in different approaches to teacher education. The ICMI study provides more information in this area.

As in other areas of teacher education approaches, it should not be surprising to find a great deal of variety in the curriculum offered to teachers within and across countries. However, this is an area in which the field suffers from definitional problems wherein labels may mean a variety of things (e.g., what is the content included in a mathematics pedagogy course?). We take as standard the different dimensions of teachers' professional knowledge (content knowledge, pedagogical content knowledge, pedagogy, knowledge of pupils, and knowledge of context) as

proposed by Shulman (1987) as a beginning point and recognizing that these still remain for the most part theoretical propositions. Participants' reports indicated whether teachers who would eventually teach mathematics after their preparation were specialists, the proportion of time dedicated to the study of the mathematics content, the mathematics pedagogy content, and/or the pedagogy content.

3a. Emphasis on Mathematics Content

The information provided by conference participants shows varied degrees of emphasis on opportunities to learn related to mathematics content. Most primary teachers are educated as generalists and most of the preparation they receive places low emphasis on mathematics content (as per the proportion of time dedicated to mathematics courses as part of their overall programme). The lack of emphasis on mathematics in primary teacher education programmes may be attenuated by those programmes' selection strategies (e.g., requiring a high level of mathematics knowledge) or by those programmes that are consecutive, thus ensuring that future teachers bring a high level of mathematics knowledge to their teacher preparation (see previous section on the structure of teacher preparation). In some cases, however, teachers graduate from programmes with little or no knowledge of mathematics. This situation also applies to the preparation of secondary teachers. However, the fact that many of these are not specialists presents yet another possible troubling trend regarding the level of mathematics knowledge teachers may hold.

3b. Emphasis on Mathematics Pedagogy

Similarly, the information gathered from ICMI participants shows varied degrees of emphasis on opportunities to learn related to mathematics pedagogy content. The study conference participants' reports on this area reveal (with some exceptions) that those who design teacher education programmes give some degree of emphasis to what we have called here "pedagogical content knowledge" in mathematics. The trend shows a higher emphasis given to this knowledge in the education of secondary teachers, while a possible troubling trend that would need to be explored further is the lack of emphasis given to pedagogical content knowledge in the education of primary teachers.

3c. Emphasis on Pedagogy

General pedagogy seems to be a major if not the only emphasis in most teacher education programmes. In contrast with the information on content pedagogy discussed previously, the report on pedagogy emphasis is more consistent. Pedagogy is given a high level of emphasis in the preparation of primary teachers and a possible troubling trend towards low emphasis in the preparation of secondary teachers.

3d. Practicum Experiences

The notion that future teachers need to have the opportunity to practice what they learn seems to be widely recognized in the field of mathematics teacher education. According to the information provided by the participants, practically every programme makes allowances for some kind of field experience. The information shows a trend that seems to signal a tendency to longer periods of practicum as an essential part of mathematics teacher preparation, thus presumably strengthening the links between theory and practice. This presumption, however, is still subject to empirical investigation.

4. Open Questions for Future Research

Important questions that remain unanswered, at least in the mostly descriptive studies, are: What are the differential effects of teacher education approaches to facilitating teachers' graduation, hiring, and permanence in the profession? What are the differential effects of teacher education approaches on the mathematics knowledge that prospective teachers acquire? What are the effects of different teacher preparation arrangements on mathematics teaching? How is pupil achievement affected by those teachers who have received diverse types of teacher preparation versus those who have not received teacher preparation? How is the teaching force affected by those teachers who enter and remain in the profession versus those who do not? For new programmes dedicating more time and resources to reach the ambitious goals set by current educational reforms, it becomes even more relevant to know the answers to these questions. The lack of research-based answers has implications for future empirical research on mathematics teacher education. Drawing from our reading of the literature and from the information provided by conference participants, we suggest possible directions for future inquiry:

1. There is a need for sound research on the characterization of teacher education systems and the paths through which they are likely to influence teacher knowledge, teacher practice, and pupil learning. This is especially true regarding issues dealing with diversity and notions on how people become good teachers, in the curricular emphasis placed on different aspects of teacher education (mathematical knowledge, pedagogical knowledge, practical knowledge), and the diverse methods for doing research on teacher education (research organized in small-scale vs. large-scale studies).
2. These studies would need to be comparative (across and within countries) and would need to better conceptualize and define the constructs and indicators of the intended cognitive and pedagogic influences of teacher education on teacher knowledge and practice moving away from reducing findings and highlighting the influence of context on these experiences.
3. It is essential to begin to explore the efficiency of teacher education and the implications of policy borrowing within and across contexts.

Examples of new questions include: What are the learning opportunities that high-quality mathematics teachers of highly performing pupils have? How are these opportunities different across contexts and diverse pupils? What are the systemic characteristics that produce and sustain these practices?

In sum, as our limited data gathering indicates, there is a growing need to design policy-oriented studies according to a typology of comparative differences within and across regions that can give better insights on the teacher education-teacher practice-pupil learning continuum, taking into account contextual differences. The framework to understand teacher education systems may include the following distinctive features: questions about the educational goals for individual learning; particular societies' ideals of an educated individual; approaches to learning, school, and classroom strategies; the level at the educational system at which these models seem to place more emphasis; countries' and systems' administrative styles; level of centralization with which the system is organized; unit costs; and financial sources. The framework may draw on similarities such as the expected processes and outcomes of teacher education. The use of a comparative framework would help educators and policy makers understand not only which characteristics of different education systems seem to have an important impact on teacher education, teaching practice, and pupil learning, but also the systemic conditions that make it possible.[3] Understanding these conditions is essential in conceptualizing viable policy.

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[3] The Teacher Education and Development Study in Mathematics (TEDS-M 2008) currently under way, seeks to answer these among other questions. TEDS-M 2008 is a comparative study of teacher education of eighteen countries, with a focus on the preparation of teachers of mathematics at the primary and lower-secondary levels. TEDS-M pays particular attention to the links between teacher education policies, practices, and outcomes. See http://teds.educ.msu.edu/.

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