Theoretical Framework, Study Design and Main Results of TEDS-M

S. Blömeke and G. Kaiser

Abstract The comparative "Teacher Education and Development Study: Learning to Teach Mathematics (TEDS-M)", carried out under the supervision of the International Association for the Evaluation of Educational Achievement (IEA), provided the opportunity to examine the outcomes of teacher education in terms of teacher knowledge and teacher beliefs both across countries and specifically with respect to mathematics for the first time. This chapter describes the conceptual framework that guided TEDS-M and its study design. The instruments used to measure teacher knowledge and beliefs as well as opportunities to learn (OTL) are described. In addition, core descriptive results, previously only published in German (see Blömeke et al. "Cross-national comparison of the professional competency of and learning opportunities for future primary school teachers", 2010a; "Cross-national comparison of the professional competency of and learning opportunities for future secondary school teachers of mathematics", 2010b (in German)), are described. These results serve as the basis for the other chapters in this monograph. It turns out that teacher education institutions structure their provision of OTL in a way that is consistent with their particular philosophy of what teachers need to know and be able to do. The need to strengthen teachers' content knowledge is one of the dominant ideas that has guided reform efforts in many countries over the past 20 years. The results of TEDS-M which are reported in this chapter are therefore crucial for policymakers. In addition, international comparisons provide benchmarks for national teacher education systems. Countries that do better in TEDS-M may have more effective teacher training programs than countries at the bottom end of the ranking.

Keywords Mathematics content knowledge (MCK) · Pedagogical content knowledge (PCK) · Comparative study · Teacher competence · Teacher beliefs · Opportunities to learn · Teacher education outcomes

S. Blömeke (✉)
Humboldt University of Berlin, Berlin, Germany
e-mail: sigrid.bloemeke@staff.hu-berlin.de

G. Kaiser
University of Hamburg, Hamburg, Germany

S. Blömeke et al. (eds.), *International Perspectives on Teacher Knowledge, Beliefs and Opportunities to Learn*, Advances in Mathematics Education,
DOI 10.1007/978-94-007-6437-8_2,

The comparative "Teacher Education and Development Study: Learning to Teach Mathematics (TEDS-M)", carried out under the supervision of the International Association for the Evaluation of Educational Achievement (IEA), provided the opportunity to examine the outcomes of teacher education in terms of teacher knowledge and teacher beliefs both across countries and specifically with respect to mathematics for the first time (Blömeke et al. 2011, 2012; Tatto et al. 2008, 2012).[1] TEDS-M was the first large-scale assessment of higher education that included direct testing of outcomes; graduates from 16 countries were surveyed. With this ambitious design, TEDS-M broadens existing research in many respects, which will be elaborated in this chapter.

Teacher education institutions structure their provision of opportunities to learn (OTL) in a way that is consistent with their particular philosophy of what teachers need to know and be able to do. The need to increase teachers' content knowledge is one of the dominant ideas that has guided reform efforts in many countries over the past 20 years (Shulman 1987). Evaluating whether these reforms have been successful is an important step towards assuring the professional quality of those working in teaching. The results of TEDS-M which we will report in this paper are there crucial for policy makers.

In addition, international comparisons provide benchmarks for national teacher education systems. Countries that do better in TEDS-M may have more effective teacher training programs than countries at the bottom end of the ranking. Studying teacher education in an international context is a challenge though. Differences in the structure and content of teacher education include the risk that the data gathered in different countries may not be comparable. At the same time, such differences are precisely that what makes comparative research so valuable. The variety of implementations makes hidden national assumptions visible (for more details on the value added of international comparisons see chapter "Framing the Enterprise: Benefits and Challenges of International Studies on Teacher Knowledge and Teacher Beliefs—Modeling Missing Links" in this book).

The present chapter describes the conceptual framework that guided TEDS-M and its study design. These descriptions have been part of several of our papers in similar versions; most recently they have been part of Blömeke (2012b) with respect to teacher competence as outcome of teacher education and the instruments used to measure teacher knowledge and beliefs as its facets. With respect to the opportunities to learn during teacher education and the instruments to gather data on them, we point to Blömeke (2012a) as well as to Blömeke and Kaiser (2012). For the purpose of this chapter, we revised and adjusted these parts. In addition, we present core descriptive results, which serve as central basis for the other chapters in this monograph, that were previously only published in German (see Blömeke et al. 2010a, 2010b).

[1]TEDS-M was funded by the IEA, the National Science Foundation (REC 0514431) and the participating countries. In Germany, the German Research Foundation funded TEDS-M (DFG, BL 548/3-1). The instruments are copyrighted by the TEDS-M International Study Center at MSU (ISC). The views expressed in this chapter are those of the authors and do not necessarily reflect the views of the IEA, the ISC, the participating countries or the funding agencies.

1 Theoretical Framework

Teacher Competence as Outcome of Teacher Education The TEDS-M concept of teacher education outcomes is based on the notion of "professional competence". Competence is defined as those latent dispositions that enable professionals to master their job-related tasks (see, e.g., Weinert 2001). These dispositions include cognitive abilities—in TEDS-M, this is the future teachers' professional knowledge—as well as convictions and values, in TEDS-M these are the future teachers' professional beliefs. Teacher competence underlies teaching performance in the classroom.

Teacher knowledge as one facet of competence can further be subdivided into different sub-facets which have been frequently discussed in the literature (Shulman 1985; Blömeke 2002; Baumert and Kunter 2006). In his seminal work, Shulman identified three content-related facets and one generic facet, namely content knowledge, pedagogical content knowledge, curricular knowledge and general pedagogical knowledge. A teacher has to develop all four of these to be able to deal effectively with the various challenges of her job: classroom management, assessment, supporting students' social and moral development, counseling and participating in school activities.

The four facets were reduced to three and defined as follows in TEDS-M (for further details, see Tatto et al. 2008):

(1) *Content knowledge* is future primary and lower-secondary teachers' mathematics content knowledge (MCK). MCK includes fundamental mathematical definitions, concepts, algorithms and procedures.

(2) *Pedagogical content knowledge*—including the Shulman facet "curricular knowledge"—is mathematics pedagogical content knowledge (MPCK). This includes knowledge about how to present fundamental mathematical concepts and methods to students adapted to their prior knowledge. Lesson planning knowledge is essential before mathematics instruction in the classroom can begin. The mathematics content must be selected appropriately, simplified and connected to teaching strategies taking into account possible learning difficulties or learning barriers caused amongst others by misconceptions of central mathematical concepts and methods. Knowledge about the way in which students learn should be taken into account when selecting a teaching strategy as well. Such knowledge requires teachers in turn to review students' answers, verbal or written, in the context of the tasks or questions given to them. Teachers should ask questions of varying complexity, identify misconceptions, provide feedback and react with appropriate scaffolding or intervention strategies. Teachers have to consider curricular issues such as the order of topics in primary or lower-secondary curriculum and need to develop their lesson planning in accordance with curricular requirements (Goos et al. 2007; Vollrath 2001). Pedagogical content knowledge may depend on the teaching and learning philosophy of the pedagogical context a teacher is working in and other cultural influences such as differences between Eastern and Western educational traditions (for more details see the final chapter in this book by Kaiser and Blömeke).

MCK and MPCK both cover mathematics, but from different perspectives. Studies by Schilling et al. (2007) and Krauss et al. (2008) demonstrate that while it is possible to distinguish between MCK and MPCK, the two knowledge facets are closely related (for more theoretical reflections on nature of mathematical subject knowledge in teaching and its relation pedagogical content knowledge see Rowland and Ruthven 2011).

(3) According to Shulman (1987) *general pedagogical knowledge* involves, "broad principles and strategies for classroom management and organization that transcend subject matter" (p. 8), as well as generic knowledge about learners and learning, assessment and educational contexts and purposes. Future mathematics teachers need to draw on this range of knowledge and transform it into coherent understanding and skills if they are to become competent in dealing with what McDonald (1992) calls the "wild triangle" that connects learner, subject matter and teacher in the classroom.

Beliefs are in TEDS-M—following a definition developed by Richardson (1996)—understood as "understandings, premises or propositions about the world that are felt to be true" (Richardson 1996, p. 103). This broad understanding is challenged by other approaches emphasizing the experiential and context-bound nature of beliefs though (Schoenfeld 1998). If beliefs are looked at alongside both the subject being taught and the professional task of teaching which needs to be mastered, evidence suggests that there is a link between teacher beliefs and the actual teaching in the classroom (Staub and Stern 2002; Voss et al. 2011). Several studies point out that beliefs are a crucial aspect of a teacher's perception of teaching situations and her choice of teaching methods (Leinhardt and Greeno 1986; Leder et al. 2002). Thus, they may also serve as an indicator of the type of teaching methods the future teachers will use in the classroom. In addition, empirical evidence exists that beliefs of the teachers influence students' achievement (Dubberke et al. 2008; Peterson et al. 1989).

Despite the rich literature about beliefs, they are not a well-defined construct. Clear distinctions between terms such as attitudes, perceptions or conceptions on the one hand and cognitive features on the other hand are rare and there exists no consensus about the various definitions and borderlines between these concepts (Goldin et al. 2009). With respect to teachers the distinction towards knowledge—in particular towards pedagogical content knowledge and general pedagogical knowledge—is more heuristic than that it can strictly be kept up (Furinghetti and Morselli 2009).

Several efforts have been made to categorize the belief systems of teachers (Thompson 1992; Op 't Eynde et al. 2002), for example epistemological beliefs on the nature of mathematics and the genesis of mathematical knowledge or beliefs on teaching and learning processes. Regarding the beliefs on the nature of mathematics, various definitions exist, which share a common ground (Liljedahl et al. 2007). An early classification by Ernest (1989) differentiates between three fundamental views of mathematics: the instrumentalist, the Platonist, and the problem solving view, which is similar to a conception by Dionne (1984), who distinguishes between a traditional view on mathematics (similar to Ernest's instrumentalist view), a formalist perspective (connected to the Platonist view by Ernest) and a constructivist perspective on mathematics (with similarities to the problem-solving view by

Ernest). Another well-known distinction by Grigutsch et al. (1998) distinguishes between a dynamic and a static view on mathematics, which are further differentiated as follows: static views on mathematics are either formalism-oriented or scheme-related views, the dynamic view on mathematics is either process-related or as new approach, application-oriented.

TEDS-M follows the latter approach and distinguishes between static and dynamic beliefs about the nature of mathematics referring to the sub-classification by Grigutsch et al. (1998). In addition, TEDS-M examines beliefs about the teaching and learning of mathematics separating transmission beliefs from constructivist views as developed by Peterson et al. (1989), and beliefs about teacher education and professional development. Self-related beliefs were not covered in TEDS-M.

With respect to the relationship between teacher knowledge and teacher beliefs, there are theories on the importance of MCK and MPCK when it comes to epistemological beliefs on the nature of mathematics (Schmidt et al. 2011). A certain level of MCK and MPCK may be needed before it is possible to see the dynamic nature of mathematics. These epistemological beliefs, in turn, probably influence beliefs on the teaching and learning of mathematics. The more a teacher is able to see the dynamic nature of mathematics, the more she may prefer student-oriented teaching methods in which students explore mathematics by themselves rather than just listening to the teacher.

Opportunities to Learn During Teacher Education TEDS-M followed the IEA tradition of connecting educational opportunity and educational achievement to determine whether cross-national differences in teacher competence were caused by differences in the teachers' opportunities to learn (OTL) during teacher education (McDonnell 1995). OTL are based on culturally influenced norms on education and intentionally developed by educational policy makers and teacher-education institutions. National and program specifications of OTL therefore reflect particular visions of what future primary and lower secondary teachers are expected to know and be able to do in a classroom and how teacher education should be organized to foster the competence necessary to master these tasks (Stark and Lattuca 1997; Schmidt et al. 2008).

The current state of research points to distinct educational philosophies that influence schooling and teacher education in different countries. Alexander (2001), in his seminal comparative study of primary school education in England, France, India, Russia and the USA, illustrated the subtle and long-term relationship between culture and pedagogy. Tobin et al. (1989, 2009) confirmed these findings with respect to early childhood education in China, Japan and the USA. Leung et al. (2006) were able to demonstrate similar cultural differences with respect to mathematics education in the East and the West.

In the same manner, data from a first comparative study on lower-secondary mathematics teacher-education programs in six countries, the "Mathematics Teaching in the 21st Century (MT21)" study (Blömeke et al. 2008; Schmidt et al. 2011), indicated that heterogeneous OTL profiles exist and that these may have been influenced by context characteristics. In five out of six countries examined, the multiple institutions where teacher education took place tended to cluster together with respect to the OTL offered, suggesting agreement *within* countries but distinct visions *between* countries, thereby reflecting a cultural effect (Schmidt et al. 2008).

OTL are probably related to teacher education outcomes. However, we know already that pure structural features, such as program or degree type, do not appear to have significant effects on short-term outcomes, such as teacher competence, or long-term outcomes, such as teacher retention or student achievement (Goldhaber and Liddle 2011). In contrast, especially in the case of mathematics teachers the evidence increasingly suggests that the *quality* of programs does have an impact on teacher outcomes (Boyd et al. 2009; Constantine et al. 2009).

Content courses in mathematics are assumed to be effective in the literature, as they deliver background knowledge and the body of deep conceptual and factual knowledge necessary to present mathematics topics to learners in a meaningful way and to connect the topics to one another as well as to the learner's prior knowledge and future learning objectives (Cochran-Smith and Zeichner 2005; Wilson et al. 2001).

Knowing the content, however, provides only a foundation for mathematics teaching. Student achievement is higher if strong content knowledge is combined with strong educational credentials (Clotfelter et al. 2007). The importance of *professional preparation*, specifically the understanding of how learners acquire mathematical knowledge, how to teach racially, ethnically and linguistically diverse students and using a wide array of instructional strategies, represents another robust finding of teacher-education research across various studies (Constantine et al. 2009; NRC 2010). Another robust finding on the impact of OTL on the outcomes of teacher education is the quality of the *teaching methods* experienced, in particular, the opportunity to engage in actual teaching practices, such as planning a lesson or analyzing student work, rather than only listening to lectures (Boyd et al. 2009).

Corresponding with these findings, OTL in TEDS-M were framed as content coverage on the one hand, specifically, as "the content of what is being taught, the relative importance given to various aspects" (Travers and Westbury 1989, p. 5). On the other hand, the concept of OTL included quality indicators, such as the teaching methods experienced. Both types of OTL were surveyed via self-reports of the future teachers. The results about how the OTL during mathematics teacher education were shaped in the TEDS-M countries and which effects they had on outcomes are presented in Chaps. 14 through 18 in this book.

It is urgent to discuss such issues of teacher education curriculum in an evidence-based manner (Blömeke and Paine 2008) rather than relying solely on anecdotal experience. For policy makers, the TEDS-M results provide information with respect to where reform is necessary *and* if it is possible to implement changes. For theory development, the results enable us to better understand the nature of teaching and teacher education.

Table 1 Participating countries in the TEDS-M primary and lower-secondary studies

Botswana	Chile	Germany	Georgia
Malaysia	Norway	Oman (lower-secondary school only)	Philippines
Poland	Russia	Spain (primary school only)	Switzerland
Singapore	Taiwan	Thailand	USA

2 Sampling

The target groups of TEDS-M were defined as future teachers in their final year of teacher education who were studying to teach mathematics in primary or lower secondary schools (Tatto et al. 2008). A teacher training program was identified as primary school level if the qualification included one of the grades 1 to 4 (primary or basic education, cycle 1; UNESCO 1997) and as lower secondary level if the qualification included grade 8 (basic education, cycle 2; UNESCO 1997).

In a two-stage process, random samples were drawn from these target groups in each participating country. The samples were organized according to important teacher education features such as the type of program (consecutive vs. concurrent programs), the school level to be taught (grade range included in the qualification, e.g. grades 1 to 4 vs. grades 1 to 10), the attention paid to OTL (in particular with or without mathematics) and the region where a teacher education institution was based (for example, federal states) to reflect accurately the future teachers' characteristics at the end of their training.

In 2008, about 14,000 future primary and 8,000 future lower-secondary teachers from 16 countries (see Table 1) were tested on their MCK and MPCK (and in three countries also on their GPK) with a standardized paper-and-pencil assessment. All countries had to meet the IEA quality requirements. These included controlling of the translation, monitoring test situations and meeting participation rates. If a country missed the participation benchmark only slightly, its results are reported with the annotation "combined participation rate less than 75 %".

In most countries, TEDS-M covered the full target population. Only Switzerland, Poland and the USA had to limit their studies for budgetary reasons: Switzerland limited its participation to German-speaking regions, Poland limited its participation to institutions with concurrent programs (90 % of all institutions), and the USA limited its participation to public universities. The situation was particularly complex in Norway. Two data sets were available that were likely to overlap. While information about the extent of a possible overlap was not available, several TEDS-M countries realized that using only one subsample would lead to strongly biased estimates for this country. After an examination of the Norwegian literature on teacher training, combining TEDS-M data with publicly available evaluation data from Norway (NOKUT 2006), and having sought the opinion of experts, these countries decided to combine the two subsamples in order to present the future Norwegian teachers' knowledge as accurately as possible. However, the results should be regarded as an approximation only.

Scaled scores in TEDS-M were created separately for MCK and MPCK in one-dimensional models using item response theory (Tatto et al. 2012). The data were analyzed on two levels of aggregation: (1) Due to the traditional policy orientation of IEA's large-scale assessments, TEDS-M focused on the country level. This approach stressed the overall educational effectiveness of a country, regardless of the structure of its education system. In this perspective, with regard to international competitiveness, it considered what a nation accomplishes as a whole—and differences in the structure of teacher-education systems between countries represented a function of differences in their educational policy. (2) Additional information was gained by looking into program types. Thus, it was possible to learn about pathways to success within countries without confounding variables like cultural or societal features. However, one has to bear in mind that the relatively small sample sizes on the country level became even smaller when types of programs were examined and that the precision of estimates was probably lower. The results of these analyses have therefore interpreted with caution.

3 Instruments

Testing MCK, MPCK and GPK TEDS-M sought to measure future teachers' MCK and MPCK in all participating countries (as mentioned GPK was only a national option, see below). For this purpose, a 60-minute paper-and-pencil assessment had to be completed during a standardized and monitored test session. The items were intended to depict classroom performance as closely as possible (see, e.g., National Council of Teachers of Mathematics (NCTM) 2000). The primary assessments consisted of five booklets with 104 items in total: 72 mathematics items and 32 mathematics-pedagogy items. The lower-secondary assessments consisted of three booklets with 103 items in total: 76 mathematics items and 27 mathematics-pedagogy items. The items were assigned to booklets following a balanced-incomplete-block design to capture the desired breadth and depth of teacher knowledge.

The mathematics items included the content areas of number, algebra (including a few items on functions and calculus) and geometry, with each set of items having roughly equal weight, as well as a small number of items about data (as that part of probability and statistics most common and relevant for teachers). The mathematics pedagogy items included aspects of curricular and planning knowledge and knowledge about how to teach mathematics. These two sets of items were given approximately equal weight. The items covered areas such as establishing learning goals, knowing different assessment formats or linking teaching methods and instructional designs, and identifying different approaches for solving mathematical problems. The items relating to knowledge about how to teach mathematics covered, for example, diagnosing typical student responses, including misconceptions, explaining or presenting mathematical concepts or procedures, and providing appropriate feedback.

The majority of items were complex multiple-choice items. Some were partial-credit items. In addition, both tests covered three cognitive dimensions: knowing (recalling and remembering), applying (representing and implementing), and reasoning (analyzing and justifying). Another feature that led the development of the items was their level of difficulty (novice, intermediate and expert). Scaled scores were created using item response theory. The achievement scores were transformed to a scale with an international mean of 500 test points and a standard deviation of 100 test points.

The items were developed among others based on the MT21 study (Schmidt et al. 2011), as well as the two Michigan studies "Knowing Mathematics for Teaching Algebra" (Ferrini-Mundy et al. 2005) and "Learning Mathematics for Teaching" (Hill et al. 2008). Released items are available on request by e-mailing tedsm@msu.edu. For more details see Tatto et al. (2008, 2012).

The instrument measuring general-pedagogical knowledge of future teachers in Germany, Taiwan and the USA consisted of 85 test items. These included dichotomous and partial-credit items as well as open-response (about half of the test items) and multiple-choice items. The items were fairly equally distributed across different teacher tasks like lesson planning, dealing with heterogeneity, motivation, classroom management and assessment. Following the MCK and MPCK test design, five or three booklets in a balanced-incomplete-block design were used.

Surveying the Future Teachers' Beliefs The future primary and lower-secondary teachers' beliefs about the nature of mathematics were surveyed using an instrument developed by Grigutsch et al. (1998). This instrument originally consisted of 75 items, but due to time constraints it was reduced to 12 items. These were selected according to both the highest factor loadings on each scale in the original study and high-scale reliability in the TEDS-M pilot studies. The items' two-dimensional structure represented a static and a dynamic view on the nature of mathematics. This structure was confirmed through explorative and confirmatory factor analysis. The future teachers had to express their agreement on a six-point Likert scale (1 = strongly disagree, 6 = strongly agree). The raw data were scaled using a partial-credit IRT model (Tatto et al. 2012). For the sake of clarity, individual scores were transformed to a scale with a mean value of 10, which represents a neutral view.

A dynamic view of mathematics sees the subject as a process of enquiry. The scale consists of six items which emphasize the process- and application-related character of mathematics, for example, "in mathematics you can discover and try out new things by yourself" or "many aspects of mathematics are of practical use". A static view of mathematics sees the subject as a set of rules and procedures. This scale consists of six items which stress the importance of definitions, formulae and mathematical facts and procedures, for example, "mathematics is a collection of rules and procedures that prescribe how to solve a problem" or "logical rigor and precision are fundamental to mathematics".

The future teachers' beliefs about the teaching and learning of mathematics were surveyed with two scales from instructional research (Peterson et al. 1989). The first scale represented a constructivist view. Strong agreement meant that teachers regarded mathematics learning as an active process in which students conduct their own enquiries and develop approaches to problem solving. Two examples of these items are: "In addition to getting the right answer, it is important to understand why the answer is correct"; and "Teachers should allow pupils to develop their own ways of solving mathematical problems".

In contrast, teachers who agreed strongly on the second scale tended to see mathematics learning as teacher-centered with the students' role being to follow instructions given. Two examples of these items are: "The best way to do well in mathematics is to memorize all the formulae"; and "Pupils need to be taught exact procedures for solving mathematical problems". The scaling happened in the same way as with respect to the nature of mathematics.

Surveying OTL TEDS-M intended to describe opportunities to learn during teacher education across countries. The topics listed in the survey were generated so as to be exhaustive of the content exposures in mathematics, mathematics pedagogy and general pedagogy in the participating countries. The future teachers indicated whether they had "studied" or "not studied" these topics. Their responses were prompted by three initial requests "Consider the following topics in university level mathematics (or mathematics pedagogy or general pedagogy respectively). Please indicate whether you have studied each topic."

Nineteen topics in mathematics were included as well as eight topics in mathematics pedagogy and eight topics in general pedagogy. For mathematics, these topics included categories such as "linear algebra", "abstract algebra", "analytic geometry" or "probability". In consultation with mathematicians in each of the countries and through a series of pilot and field studies, these categories were found to have essentially the same meaning across countries. Mathematics pedagogy included categories such as "mathematics standards and curriculum", "development of mathematics ability and thinking", or "developing teaching plans". The history, philosophy and sociology of education were included under general pedagogy as were topics related to assessment, teaching and the theory of schooling. National expert reviews and pilot studies ascertained the cultural validity of these items in all participating countries.

10 items captured how well the future teachers were prepared for specific professional challenges: the diversity of students in a mathematics class and the need for continuous professional development. The items had to be rated on 4-point Likert scales ranging from "never" to "often" after the initial request "In your teacher preparation program, how often did you have the opportunity to learn to do the following?" Examples of items were "Develop specific strategies and curriculum to teach pupils from diverse cultural backgrounds", "... with behavioral and emotional problem" or "... gifted pupils" on the one side and "Develop strategies to reflect upon the effectiveness of your teaching“ or "... upon your professional knowledge" on the other side.

The teaching methods experienced at university had to be rated on the same type of 4-point Likert scales. Again the items listed were generated so as to be the union of methods exposures across the participating countries. The 15 items covered typical teaching methods used in most programs at a university (e.g. “Listen to a lecture” or “Make presentations to the rest of the class”) but also methods typical for teacher education only (e.g. “Teach a class session using methods demonstrated by the instructor”) or methods typical for mathematics programs only (e.g. “Solve a given mathematics problem using multiple strategies” or “Write mathematical proofs”). The research aspect of university programs was covered as well (e.g. “Read about research on mathematics education”).

4 Results

Detailed information and complex analyses are reported from Chap. 4 in this book. The main function of the present chapter is to provide an overview of the most important descriptive results on the country level to frame the later in-depth results. As far as we can see, this basic information has not yet been published in English but only in German (Blömeke et al. 2010a, 2010b) since the official TEDS-M report is limited to program types as the unit of analysis (Tatto et al. 2012).

Structure of Primary and Lower-Secondary Teacher Education Primary school covers grades 1 through 6 in many TEDS-M countries. Correspondingly, teacher education prepares for teaching in these grades. In most countries, the primary teachers examined in TEDS-M were prepared as generalists either for grades 1 through 3 (e.g., in Poland and Taiwan) or up to grade 6 (e.g., in the Philippines or Spain). The role of generalists means that as head (or class or form) teachers they will have to teach most subjects in one class. During teacher education the future primary teachers had opportunities to go into more depth with respect to the content of three or four subjects, among others in mathematics.

Germany is an exception as primary school in most federal states includes only four grades and teacher education either prepares for teaching in these (as generalists) or for teaching up to grade 10 (then prepared as specialists in two subjects, in the context of TEDS-M one of these would have been mathematics). Most countries offer two pathways into teaching: a 4-year concurrent and a consecutive route with a basic Bachelor degree followed either by a teaching license or a Master degree. The majority of future teachers were enrolled in a concurrent program. Also in this respect Germany is an exception as its teacher education system combines important features of both approaches (“hybrid system”).

Lower-secondary school in most of the TEDS-M countries consists of the grades 7 to 9 (Tatto et al. 2012). Teacher education prepares for the teaching of one or two subjects in either in these grades only (e.g., in Taiwan) or in grades 7 through 12 (e.g., in Georgia). In the context of TEDS-M, one of the subjects would be mathematics. Else, the characteristics of the teacher education system are similar to primary teacher education.

Background of Future Primary and Lower-Secondary Teachers at the End of Their Training Seen across all TEDS-M countries, *a typical primary teacher at the end of her training* was on average 24 years old and female. Her parents typically had a degree on the UNESCO (1997) classification levels 3 or 4 (educational degree from an upper- or post-secondary institution) and there was on average a medium amount of books in her parents' homes (between 26 and 100). Typically, there was a computer in these homes as well. The teacher's prior knowledge from schooling was on average high: 12 years of mathematics and good or even very good grades across all school subjects compared to her age cohort. The language of teacher education typically fit to the language spoken at home. Intrinsic pedagogical motives dominated the decision to become a teacher much more than extrinsic status motives but also more than intrinsic intellectual motives.

Not surprisingly there was huge *variation* between countries with respect to these average characteristics of future primary teachers. It seems as if teachers from consecutive programs were older than those from concurrent programs. And whereas future primary teachers in the Philippines and Georgia were on average only 21 years old at the end of their training, teachers from Germany were already 27 years old. This high age at the end of their training was an accumulated consequence of many different societal, schooling and teacher education features. In none of the TEDS-M countries males represented the majority of primary teachers at the end of their training. However, a tendency existed that their proportion increased if their program required more mathematics or if they had to teach higher grades.

In many TEDS-M countries the educational background of the primary teachers' mothers and fathers was roughly equal. This did not apply to all countries though. In Germany, Switzerland and Spain mothers on average had lower, in Russia, Poland and Georgia mothers had higher degrees than fathers. These differences are probably related to the role of women in these societies (Hradil 2001; UNICEF 1999).

The number of books in the parents' homes varied between countries as well. In Germany and Norway the future primary teachers' cultural capital was especially high. Strikingly high was also the cultural capital of teachers in Georgia and Russia given their rank on the UN Human Development Index. This result might reflect high educational aspirations in these societies (Alexander 2001). In general, one has to notice that in most countries the teachers' cultural capital was higher than the cultural capital of K-12 students. The much lower number of books reported by the latter group (for example, in TIMSS; Mullis et al. 2008) points to a selection effect.

With respect to the language spoken at home compared to the official language in teacher education (i.e. the test language of the TEDS-M tests and surveys), a distinct difference between two groups of countries existed that is not reflected in the portray of a typical primary teacher presented above. In one group that included Botswana, Malaysia, and the Philippines, future teachers were tested in English whereas this was the language spoken at home only for a small minority. We also found substantial proportions of teachers speaking a different language at home compared to teacher education in Singapore (Malay, Chinese or Tamil vs. English), Thailand (several different languages and dialects, among others Kadai or Chinese, vs. Thai) and Taiwan (Taiwanese vs. Mandarin). In contrast, in many countries almost every future primary teacher spoke the official test language at home—although we sometimes found substantial proportions of language diversity in these countries as well (e.g., in Germany and the USA).

Interesting variation between countries existed also with respect to the motivation why the future teachers went into teacher education. Primary teachers in the USA, Switzerland, Norway, Germany, Spain, and Chile stated particularly strongly pedagogical motives in relation to intellectual or extrinsic motives. This result might be related to the long-standing tradition of child-orientated pedagogy in these countries. In contrast, future teachers in the Asian and Eastern European countries stressed particularly strongly the intellectual challenge of teaching. This result might be related to the high value of mathematics in these countries and in the East Asian countries in addition to their Confucian heritage and its valuing of teachers. With the teaching of higher grades and the study of more mathematics, the intellectual motive was on average more strongly supported.

One more split between countries existed with respect to the extent future primary teachers felt limited by financial or familial constraints during their studies. On the one side, we found countries where future teachers stressed family obligations more strongly than financial worries. This applied to all Asian countries in TEDS-M as well as to Botswana and Chile. On the other side, we had the Western countries and Poland where financial limitations dominated in relation to familial issues. It is probably not far-fetched to relate this result to cultural differences as they were expressed by the Hofstede (2001) continuum of collectivism and individualism.

A typical lower-secondary teacher at the end of teacher training showed many similarities with primary teachers in her background characteristics. She was typically aged 24 and female. The teacher's parents had on average a degree at level 3 or 4 of the UNESCO (1997) ISCED classification and they had between 26 and 100 books at home. They usually had a computer as well. The typical future lower-secondary teacher had completed 12 years of mathematics classes and had good or even very good grades compared to her peers. The language of teacher education was typically the language spoken at home. On average, the future teachers had entered teacher education for intrinsic pedagogical reasons. They were less interested in extrinsic status reasons or intrinsic intellectual reasons.

Also in this group of future teachers huge *variation* between countries existed. Teachers in consecutive programs were on average older than those in concurrent programs. Although in most TEDS-M countries the majority of lower-secondary teachers in their final training year were women, in three countries—Botswana, Taiwan and Switzerland—the majority were men. In Germany, the mothers of the future teachers had on average reached a lower level of higher education than the fathers, whereas in Russia and Poland the mothers hold higher-level degrees.

In Germany, Norway and Switzerland the teachers' cultural capital was especially high. The cultural capital of teachers in Georgia was high given this country's rank on the UN Human Development Index. Also with respect to future lower-secondary teachers, the cultural capital is higher than that of their students. The language split between countries was for future lower-secondary teachers very similar to the grouping of countries with respect to primary teachers. In Oman, where only lower secondary teachers took part in TEDS-M, significant proportions of teachers spoke a different language at home to the one used in teacher education (Persian or Indian vs. English).

Future lower-secondary teachers in the USA, Switzerland, Norway, Germany, Chile and Singapore particularly strongly selected pedagogical motives over intellectual or extrinsic motives to explain their career choice. In contrast, future teachers in Poland, Russia and Oman stressed more strongly the intellectual challenge of teaching compared to other reasons that had motivated their choice of career. In Taiwan, the Philippines, Malaysia, Georgia and Thailand extrinsic motives dominated the reasons given for becoming a teacher.

Similar to the results of primary teachers, future lower-secondary teachers from all Asian countries in TEDS-M as well as from Botswana and Chile stressed particularly strongly family obligations over financial worries when describing factors that limited their study. On the other hand, in the Western European countries and the USA financial limitations dominated over family issues. These results can once again be explained by looking at cultural differences as expressed by the Hofstede continuum of collectivism and individualism (Hofstede 2001).

Opportunities to Learn (OTL) During Primary and Lower-Secondary Teacher Education The extent of OTL in mathematics varied a lot between the TEDS-M countries. In Thailand where they trained specialists for this school subject even on the primary level, future teachers have covered the most topics. Germany is one of the countries where the extent of OTL in mathematics was significantly below the international average. This result was mainly a function of one program type in which mathematics was neglected (primary and lower-secondary teachers without specialization in mathematics). Graduates from the other three types covered significantly more mathematical topics during their training.

It is possible to identify an international profile of OTL in mathematics: Number was a dominant field of study in primary teacher education followed by data and within certain limits geometry. Calculus was in most countries of significantly lower importance. Another commonality across countries was the relatively high amount of OTL taken in general pedagogy, and this with respect to theoretical as well as practical topics. There seemed to be a consensus that general pedagogy had to be a vital part of teacher knowledge. Less agreement existed with respect to mathematics pedagogy, specifically with its theoretical part. Germany was one of the countries with the lowest extent of OTL in this field.

Teacher educators play an important role in providing OTL. On average more than half of the teacher educators in the TEDS-M countries were female. The proportion of teacher educators with a degree on ISCED level 6 (at least PhD) varied between the countries: between 0 % in Botswana and 82 % in Georgia.

Lower-secondary teacher education was also characterized by considerable variation in the OTL in mathematics, mathematics pedagogy and general pedagogy between the TEDS-M countries. At the end of their training, future teachers in Germany, Poland, Russia, Georgia, Taiwan, Oman and Thailand indicated more OTL in mathematics compared to mathematics pedagogy and general pedagogy. In contrast, lower-secondary teacher education in Norway, the USA, Chile and Botswana focused particularly strongly on pedagogical topics. In the first set of countries the focus was obviously on the content, whereas in the second set the teaching of the content was considered most important.

In Botswana, Singapore, Georgia, Malaysia, Oman and Taiwan there were particularly many OTL in calculus compared to number, geometry and data. This result suggest that mathematics teacher education in these countries focused on the higher grades of lower-secondary school. In Norway, Switzerland, the USA and Chile the OTL in calculus were low, which suggested an orientation towards the lower grades.

Overall, lower-secondary mathematics teachers, who were also qualified to teach at the upper-secondary level, had significantly more OTL in mathematics than their peers who were intending to teach at the lower-secondary level. In Norway and Chile, where lower-secondary teachers were trained as generalists, and in Germany and Singapore, where they were trained in two subjects, the future teachers reported the fewest OTL in mathematics.

MCK, MPCK and GPK as Outcomes of Primary Teacher Education Significant mean differences in teacher-education outcomes in terms of MCK, MPCK and GPK existed between the countries involved in TEDS-M. The data revealed a wide range of what was accomplished in primary teacher education. The ranking of countries and teacher education programs according to these outcomes provided international benchmarks to evaluate the effectiveness of the education that future primary teachers received.

Taiwan and Singapore achieved the best results with respect to MCK and MPCK (see Tables 2 and 3). The difference to the international mean of 500 test points was large, at approximately one standard deviation which is a highly relevant difference (Cohen 1988). Switzerland, Norway and the USA achieved results significantly above the international mean in both facets as well while primary teachers from Georgia, Chile, Botswana, the Philippines, Spain and Poland were significantly below the international mean in both facets (for further details, see Blömeke et al. 2011, 2012).

Interesting differences exist with respect to achievement in MCK and MPCK which require more research. Whereas Singapore was behind Taiwan in case of MCK, the countries were on the same level in case of PCK. With respect to MPCK, Norway and the USA were only one half of a standard deviation behind the two East Asian countries whereas the difference was up to one standard deviation with respect to MCK. Malaysia scored around the international mean in MPCK whereas the country scored below the mean in MCK. Russia, Thailand, and Germany performed significantly lower in MPCK than in MCK. These differences are worth to be examined in detail. They may point to country-specific strengths and weaknesses.

Table 2 MCK of future primary teachers at the end of their training by country (M = mean, SE = standard error, SD = standard deviation)

Country	M	SE	SD
Taiwan	623	4.2	84
Singapore	590	3.1	74
Switzerland[*]	543	1.9	66
Russia	535	9.9	91
Thailand	528	2.3	75
Norway[a,n]	519	2.6	73
USA[**,a,b]	518	4.1	69
Germany	510	2.7	83
International	500	1.2	100
Poland[***,a]	490	2.2	98
Malaysia	488	1.8	54
Spain	481	2.6	57
Botswana	441	5.9	48
Philippines	440	7.7	52
Chile[a]	413	2.1	65
Georgia	345	3.9	85

[*]Pedagogical universities in German-speaking cantons

[**]Public universities

[***]Institutions with concurrent teacher-educations programs

[n]Sample meets the TEDS-M definition only partly, deviation from the IEA report

[a]Combined participation rate <75 %

[b]Substantial proportion of missing values

Table 3 MPCK of future primary teachers at the end of their training by country (M = mean, SE = standard error, SD = standard deviation)

Country	M	SE	SD
Singapore	593	3.4	71
Taiwan	592	2.3	68
Norway[a,n]	545	2.4	64
USA[**,a,b]	544	2.5	68
Switzerland[*]	537	1.6	64
Russia	512	8.1	83
Thailand	506	2.3	70
Malaysia	503	3.1	67
Germany	502	4.0	92
International	500	1.3	100
Spain	492	2.2	63
Poland[***,a]	478	1.8	101
Philippines	457	9.7	67
Botswana	448	8.8	75
Chile[a]	425	3.7	90
Georgia	345	4.9	100

Annotations are explained above (Table 2)

With respect to the achievement of primary teachers coming from different program types, MPCK is taken as an example in this summary (with respect to MCK

Table 4 Mathematics knowledge in grade 4, in grade 8 and at the end of primary teacher education (M = mean, d = Cohen's d)

Country	TIMSS 2007—Grade 4		TIMSS 2007—Grade 8		TEDS-M 2008	
	M	d	M	d	M	d
Taiwan	576	+0.9	598	+1.0	623	+1.3
Singapore	599	+1.1	593	+1.0	590	+1.0
Russia	544	+0.5	512	+0.1	535	+0.4
Norway[a,n]	473	−0.3	469	−0.4	519	+0.2
USA[**,a,b]	529	+0.3	508	+0.1	518	+0.2
Germany	525	+0.3	–	–	510	+0.1
International	500	0.0	500	0.0	500	0.0
Georgia	438	−0.7	410	−0.9	345	−1.7

Annotations are explained above (Table 2)

see Blömeke et al. 2010a). Not surprisingly specialists show the best performance. No MPCK mean of any program type was significantly below the international mean of 500 test points. Single results of teachers from other programs were more striking though. In Taiwan, Singapore, and Norway future teachers from non-specialist programs showed high achievement in MPCK, too. At the same time we have to notice huge differences within countries, for example in Poland and Germany. In these two countries it is possible to teach mathematics in primary schools either with a license from a generalist or a specialist program. The average MPCK achievement of these programs differed by about a full standard deviation.

The achievement of future primary teachers from countries which, according to the UN Human Development Index (HDI), were classified as developed or highly developed, was often above the international mean. This did not apply to Germany, Poland and Spain though so that for these three countries it seems to be necessary to examine in detail potential problems of their mathematics teacher-education systems. In contrast, given their positions on the HDI, the performance of teachers from Russia and Thailand (and partly also form Malaysia) was remarkably good.

For seven countries, comparisons between the TEDS-M results and the TIMSS results of grades 4 and 8 (Mullis et al. 2008) are possible on the country level. The effect size "Cohen's *d*" represents the deviation of a country's score on each scale from the respective international mean. Conclusions have, of course, to be drawn only very cautiously because of the complex relationship between student achievement and teacher achievement. But all in all, the results show astonishingly clear similarities of the country-level results for grade 4, grade 8 and primary teacher education (see Table 4). The same countries, namely Singapore and Taiwan, show outstandingly high achievements in all large-scale assessments with roughly the same effect sizes. Likewise, the achievement of Russia, Germany and

Table 5 Correlations between future primary teachers' MCK and MPCK by country (Pearson's *r* and standard errors)

Country	*r*	SE
Poland[***,a]	0.68	0.01
Germany	0.62	0.03
Russia	0.58	0.05
Norway[a,n]	0.53	0.03
Thailand	0.50	0.03
USA[**,a,b]	0.48	0.03
Chile[a]	0.46	0.03
Malaysia	0.44	0.05
Taiwan	0.43	0.04
Spain	0.41	0.03
Georgia	0.38	0.03
Switzerland[*]	0.38	0.03
Singapore	0.34	0.04
Philippines	0.34	0.04
Botswana	0.28	0.11

Annotations are explained above (Table 2)

the USA was each time higher than the international mean while Georgia scored significantly below the mean. Only with respect to Norway we have to note a gap between the students‘ and the teachers‘ results. The future primary teachers performed, relatively speaking, better than the students in both K-12 assessments.

The analyses done so far have revealed that the country rankings for MCK and MPCK were similar. Indeed, MCK and MPCK conceptually overlap as MCK must be regarded a precondition for mastering tasks that require MPCK. Nevertheless, only a few countries showed very high correlations between MCK and MPCK (see Table 5) while the correlations differed between the countries participating in TEDS-M: In Poland and Germany, both knowledge facets co-varied strongly so that we can speak of closely related facets. In contrast, in Botswana, the Philippines, Singapore, Georgia and Switzerland low correlations existed. At present, it is unclear what might be the reason for these differences between the countries, as neither only countries with top-performing teachers showed high correlations (as an opposite example see, e.g., Poland) nor countries with low-performing teachers showed low correlations only (as an opposite example see, e.g., Switzerland). Similarly, neither only European countries showed high correlations (as an opposite example see, e.g., Thailand) nor non-European countries showed low correlations only (as an opposite example see, e.g., Botswana).

If one compares the countries according to their relative strengths in MCK vs. MPCK, three groups are distinguishable: In the Asian countries Taiwan and Thailand and the four European countries Russia, Poland, Germany and Switzerland future primary teachers performed better in MCK in relationship to MPCK. In contrast, teachers in Norway, the USA, Spain and Chile as well as in Malaysia and the Philippines were characterized by their relative strengths in MPCK compared to MCK. In Georgia, Singapore and Botswana balanced profiles can be observed. These knowledge profiles did not correlate with the absolute levels of achievement. This result shows that there is no single ideal way to gain strong achievement in both knowledge facets (for details and a discussion of this result see the chapter by Kaiser and Blömeke in this book).

However, it may be that cultural traditions play a role for shaping the profiles. In East-Asian countries, subject-based knowledge is given high value (Leung 2001). A teacher is regarded an expert of a subject (Leung et al. 2006) but subject-related knowledge plays a significant role in Continental and Eastern Europe, too (Alexander 2001; Kaiser et al. 2006). This tradition contrasts with the child-oriented concept prevalent in Scandinavia as well as in North and South America.

The aggregated MCK score does not show the teachers' strengths or weaknesses in subdomains like number, algebra or geometry. Therefore, based on the proportion of correct responses, the relative achievement in these subdomains was examined (for details how these relative scores were estimated see Blömeke et al. 2010a). The primary teachers solved correctly on average 62 % of the number and the algebra items and 59 % of the geometry items. The range was between 25 and 31 % in Georgia to 79 and 85 % in Taiwan.

Future teachers in Taiwan, Thailand, Switzerland and the USA showed a relative strength on number items and relative weaknesses in geometry and algebra. This profile meets the demands of the lower primary grades. In four countries, including Germany, the future primary teachers showed a relative strength in algebra but weaknesses in number and geometry. Such a profile indicates an orientation at teaching on the lower secondary level. This matches for instance with Germany's teacher education where about half of the future primary teacher population consists of teachers trained for teaching in grades 1 through 10. Teachers of the third group showed a balanced profile across the three subdomains.

The international TEDS-M team developed cut scores in order to describe different performance levels in MCK and MPCK (for details how this was done see Tatto et al. 2012). For MCK, two thresholds and thus three groups of future primary teachers could be distinguished. The best-performing group, positioned above the second threshold, consisted of teachers who had extensive MCK, could solve standard problems with a high probability and who, in order to give an example,were able to identify irrational numbers with a probability higher than 70 %. Across all TEDS-M countries, about two fifths of the teachers belonged to this group. While in Taiwan and Singapore more than 80 % of the future primary teachers were part of this group, in other countries like Georgia, Chile, the Philippines and Botswana only less than 10 % fall into this group. In Germany, the USA and Norway approximately 50 % of the primary teachers fall into this highest-performing group.

Future primary teachers in the middle group, between the first and the second threshold, were equipped with a basic understanding of natural and whole numbers, but they experienced difficulties when they had to apply number theory-related concepts. They were able to construct and interpret two- and three-dimensional geometric forms and to calculate its surface area, but they had difficulties with geometric forms in a representation of coordinates. In algebra, they were familiar with variables and could execute equivalence transformation, but they had difficulties in recognizing square and functional exponential relationships. In most of the TEDS-M participating countries around 30 to 50 % of primary teachers belong to this group.

Low MCK was reported for one fifth of the future primary teachers that belonged to the third group below the first threshold. These teachers suffered from a deeper understanding and they faced problems with example-related argumentation. They had problems in dealing with natural and rational numbers. In algebra, for instance, they did not succeed in carrying out visually represented equivalence transformation. Likewise, it was difficult for them to correlate various mathematical concepts and to develop argumentative proofs. Only in Taiwan, Singapore and Switzerland less than five % of the teachers belonged to this group. In contrast, 88 % of all teachers in Georgia and 60 % of the teachers in Chile had such a low MCK while in Botswana and the Philippines still around 40 % represented this level of knowledge. In Germany, Russia, Thailand, Norway, the USA and Malaysia between 7 and 12 % of future primary teachers belonged to this group. These results point out that in these countries primary teachers showed clear deficits.

A brand new field of research is the assessment of teachers' GPK. TEDS-M was the first comparative study that addressed this dimension. Germany and Taiwan assessed the knowledge of future primary teachers about lesson planning, classroom management, motivation, dealing with heterogeneity and assessment—each dimension was subdivided into three cognitive tasks (recalling, understanding and creating). The main result was that German future primary teachers significantly outperformed US teachers. The difference was about one standard deviation overall as well as within respect to each subdimension and it was therefore highly relevant. Within German graduates from pure primary programs performed significantly better than students from combined primary and lower-secondary programs.

MCK, MPCK and GPK as Outcomes of Lower-Secondary Teacher Education
With respect to MCK, by far the best result was achieved by future lower-secondary teachers in Taiwan (see Table 6). Their MCK was more than 1.5 standard deviations higher than the international mean. In addition, Taiwan exceeded the achievement of teachers from the second-best country, Russia, by more than half a standard deviation. Even the lowest achievers from Taiwan had better results than the best results achieved in Chile, Georgia, Botswana, the Philippines, Norway and Oman, as indicated by the respective 5^{th} or 95^{th} percentiles.

Russia together with Singapore, Poland, Switzerland and Germany belonged to a group of countries where the MCK was significantly higher than the international mean. It is remarkable that with Poland and especially Russia two countries belong to this group whose developmental level (HDI) was lower than that of the other countries. With respect to Switzerland, we have to point out that only lower-secondary teachers participated in TEDS-M who were educated at Pedagogical Universities. If teachers educated at universities for teaching at the upper-secondary

Table 6 MCK of future lower-secondary teachers (M = mean, SE = standard error, SD = standard deviation)

	M	SE	SD
Taiwan	667	3.9	75
Russia	594	12.8	96
Singapore	570	2.8	61
Poland[***,a]	540	3.1	66
Switzerland[*]	531	3.7	50
Germany	519	3.6	94
USA[**,a,c]	505	9.7	67
International	500	1.5	100
Malaysia	493	2.4	51
Thailand	479	1.6	59
Oman	472	2.4	47
Norway[b,n]	444	2.3	63
Philippines	442	4.6	49
Botswana	441	5.3	39
Georgia[a]	424	8.9	84
Chile[a]	354	2.5	84

Annotations are explained above (Table 2)

level (grades 10 to 12) were included, the country might have achieved even better results.

The MCK of future lower-secondary teachers from the USA and Malaysia did not differ significantly from the international mean. Significantly below the international mean were the results of Thailand, Oman, Norway, the Philippines, Botswana, Georgia and Chile. The MCK in the latter country was 1.5 standard deviations below the international mean. According to its HDI, Chile is similarly developed like Poland but much higher than Thailand, Georgia, the Philippines or Botswana. However, even more worrying was the achievement of Norway, one of the highest-developed countries in the world.

As with respect to primary teachers, all in all astonishingly similarities of the TEDS-M results with the TIMSS results at grade 8 can be noted (see Table 7). In all countries where the teacher population performed above the international mean, the K-12 student achievement was higher as well and vice versa. Also the country ranking came out quite similar in both studies.

The TEDS-M results with respect to MPCK were comparable with those to MCK. Again Taiwan and Chile represented the best and lowest performing countries. However, the deviation from the international mean was lower in the case of MPCK than MCK. In general, the results of the participating countries did not vary so much. Similar to MCK, five countries performed significantly higher than the international mean (see Table 8): Russia, Singapore, Switzerland, Germany and Poland. Once more, it must be pointed out that especially the MPCK results of Russia, a country which according to its HDI is classified as a relatively low developed country, were remarkable. This might indicate strength of the East-European

Table 7 MCK in grade 8 and at the end of lower-secondary teacher education (M = mean, d = Cohen's *d*)

Country	TIMSS 2007—Grade 8		TEDS-M 2008	
	M	d	M	d
Taiwan	598	+1.0	667	+1.9
Russia	512	+0.1	594	+1.0
Singapore	593	+1.0	570	+0.8
USA[**,a,c]	508	+0.1	505	+0.1
International	500	–	500	–
Malaysia	474	−0.3	493	−0.1
Thailand	441	−0.6	479	−0.3
Norway[b,n]	469	−0.4	444	−0.7
Philippines	378*	−1.3	442	−0.7
Botswana	364	−1.5	441	−0.8
Georgia[a]	410	−0.9	424	−0.8
Chile[a]	387*	−1.2	354	−1.6

Annotations are explained above (Table 2)

tradition of education. In contrast, it must be stated again that Norway, a highly-developed country, fell far behind the international mean. Although there were similarities in the MCK and MPCK results, it is at the same time important to distinguish between the two facets. Whereas Malaysian teachers scored only slightly below the international mean in MCK, they had much lower scores when it came to MPCK, for example. Such differences are worth examining in detail. They may point to specific strengths and weaknesses in teacher education in the different countries.

Comparable to the primary results, the conceptual overlap of MCK and MPCK led to varying correlations between these (see Table 9). While in Germany, Russia, Poland and the USA it was almost not possible anymore to separate the two facets, in Botswana a systematic correlation did not exist at all. For the moment, it is not yet clear, what the reason might be for these remarkable differences.

Country-specific profiles with respect to relative strengths and weaknesses in MCK and MPCK can be recognized. Three groups of countries can be distinguished: In the three Western European countries Germany, Switzerland and Norway together with Chile and Georgia, future teachers showed relative strength in MPCK compared to MCK. In contrast, future teachers in the East-European countries Russia and Poland, in the Asian countries Singapore, Taiwan, Malaysia and also in Botswana performed relatively better in MCK than in MPCK. In the third group, consisting of the USA, Thailand, Oman and the Philippines, an even result for both knowledge areas came out. The profiles varied independently from the absolute performance level. The profiles might rather reflect cultural traditions. For instance, in East-Asian countries which are strongly influenced by Confucian philosophy (e.g., Singapore and Taiwan) teachers are regarded as experts of the content and they are given the role of "scholar-teachers" (Leung et al. 2006, p. 43). Therefore, a great proportion of teacher education consists of subject-related components. In East-European countries, subject-based knowledge plays an important

Table 8 MPCK of future lower-secondary teachers (M = mean, SE = standard error, SD = standard deviation)

Land	M	SE	SD
Taiwan	649	5.2	95
Russia	566	10.1	96
Singapore	553	4.7	84
Switzerland[*]	549	5.9	72
Germany	540	5.1	96
Poland[***,a]	524	4.2	81
USA[**,a,c]	502	8.7	75
International	500	1.6	100
Thailand	476	2.5	64
Oman	474	3.8	66
Malaysia	472	3.3	61
Norway[b,n]	463	3.4	72
Philippines	450	4.7	60
Georgia[a]	443	9.6	79
Botswana	425	8.2	59
Chile[a]	394	3.8	88

Annotations are explained above (Table 2)

role as well (Alexander 2001). In contrast, since the era of the Reform Pedagogic, learner-focused and constructivist approaches have existed in Continental Europe but also in Chile, a country strongly influenced by European traditions (for details see the chapter by Kaiser and Blömeke in this book).

The aggregated proportions of correct solutions by content domain revealed interesting strengths or weaknesses as well. The future lower-secondary teachers solved correctly 47 % of the algebra, 52 % of the number and geometry items as well as 55 % of the MPCK items related to issues of curriculum and planning and 59 % of the MPCK items related to interaction in classroom. The algebra test was obviously more difficult than other tests but the differences were small. Relative strengths in geometry combined with relative weaknesses in number and algebra were shown by future lower-secondary teachers in Norway and Malaysia. In contrast, a relative weakness in geometry combined with relative strengths in number and algebra were revealed for Germany, the Philippines, Oman, Botswana, Taiwan and Poland. Switzerland, Thailand and Singapore demonstrated a relative weakness in algebra combined with relative strengths in number and geometry. In the remaining countries, the teachers displayed a knowledge profile largely corresponding with the international mean.

With respect to MCK, like in the primary study, two thresholds were identified that distinguished three groups of future lower-secondary teachers (490 and 560 test points). Due to the small number of MPCK items only two levels could be distinguished here (510 test points). The test items located at the thresholds describe for each competence level the minimum of existing knowledge and the not-existing

Table 9 Manifest correlations between future lower-secondary teachers' MCK and MPCK by country (Pearson's r and standard errors)

Land	r	SE
Germany	0.70	0.03
Russia	0.68	0.04
Poland[***,a]	0.67	0.05
USA[**,a,c]	0.64	0.03
Georgia[a]	0.56	0.11
Singapore	0.55	0.04
Norway[b,n]	0.53	0.04
Malaysia	0.52	0.04
Chile[a]	0.51	0.03
Thailand	0.50	0.03
Taiwan	0.45	0.04
Oman	0.44	0.04
Switzerland[*]	0.40	0.08
Philippines	0.37	0.10
Botswana	0.18	0.14

Annotations are explained above (Table 2)

knowledge (for a detailed description how the levels were found and item examples see Blömeke et al. 2010b).

In Taiwan, almost all future lower-secondary teachers reached the highest competence level. With a probability of more than 70 % they were able to apply university-level definitions, theorems and algorithms in calculus, algebra and higher geometry. They had a profound knowledge of elementary and complex operations and they were also able to apply abstract definitions and formalisms. Further, they knew how to solve abstract algebraic or geometric problems by referring to axiomatic definitions. In Russia and Singapore, the majority of the teachers performed also at this high competence level.

In contrast, a group of nine countries had the largest proportion of teachers—or even the majority of teachers—on the lowest competence level: the USA, Thailand, Malaysia, Georgia, Oman, Norway, the Philippines, Botswana and Chile. Teachers on this level had only basic knowledge of rational numbers, and, at a limited degree, they were able to execute simple calculations, such as solving linear or simple quadratic equations, especially by applying trial-and-error methods. They were also able to solve problems with whole numbers. Further, they were able, at a limited degree, to deal with fundamental two- and three-dimensional geometric figures, as well as they were able to recognize and produce simple geometric figures. All in all, these teachers' knowledge was limited to school knowledge of the secondary level and its application to known types of problems.

It is interesting to note that the TEDS-M data did not necessarily support the hypothesis that teachers in consecutive programs did better than teachers in concurrent programs. Another important outcome was that test results improved when future lower-secondary teachers had more OTL in mathematics. German lower-secondary teachers who were trained to teach on the upper-secondary level as well (up to grade 12) showed an outstanding level of MPCK, for example. In contrast, German mathematics teachers qualified to teach up to grade 10 did less well.

Germany, Taiwan and the USA assessed their lower-secondary teachers' GPK as well. The German and Taiwanese teachers significantly outperformed their US counterparts.

Beliefs as Outcomes of Teacher Education Finally, beliefs were captured as teacher-education outcomes in TEDS-M. There was huge variation between and within countries—however, it was possible to identify profiles which seemed to be influenced by cultural features, specifically on the Hofstede continuum of individualism and collectivism. In individualistic countries like Germany, future primary teachers specifically stressed dynamic aspects of mathematics in relation to static aspects and constructivist principles of teaching and learning in relation to transmission-orientated principles. In contrast, in collectivistic countries the support of static and transmission aspects was relatively high compared to the support of dynamic and constructivist aspects. Countries which seemed to be moving from collectivism to individualism according to Hofstede's index were positioned in the middle of the TEDS-M countries as well. If a country deviated in TEDS-M from Hofstede's index (e.g., Poland), the special tradition of mathematics might be an explanation. Within Germany the profile of beliefs varied according to program types. The more mathematics a future teacher had taken, the more she supported dynamic and constructivist beliefs.

The results for lower-secondary future teachers were much the same. Whereas future teachers in Germany, Switzerland, Poland and Norway either had a neutral view of mathematics or even denied its static nature, teachers in the Philippines, Thailand, Malaysia and Botswana agreed with statements that mathematics mainly involves algorithms. There was more agreement between teachers in the different countries when it came to the dynamic nature of mathematics. In all countries, future teachers reacted positively to statements that stressed the creativity and usefulness of mathematics.

When comparing how strongly teachers agreed with both notions in relation to each other, certain profiles appeared. Future teachers from countries like Malaysia and Thailand expressed much more agreement with static beliefs than with dynamic beliefs. In contrast, teachers from countries like Germany and Switzerland agreed more strongly with dynamic beliefs than with static beliefs. These results can be linked to Hofstede's index of individualism and collectivism (Hofstede 2001).

With respect to constructivist and transmission beliefs on the teaching and learning of mathematics, lower-secondary teachers in Germany, Switzerland and Norway rejected teacher-led learning, whereas teachers in the Philippines and Malaysia supported it. In contrast, agreement with statements that support student orientation was high in all countries. In line with the results on the nature of mathematics, a relationship to the countries' positions on Hofstede's scale of individualism and collectivism was revealed when comparing the relative endorsement of constructivist and transmission views. In Switzerland, Germany, Norway, the USA and Poland—countries characterized by individualism—the future teachers stressed the importance of student orientation over teacher orientation particularly strongly. In contrast, teachers in Russia, Singapore, the Philippines and Malaysia stressed teacher orientation particularly strongly compared to student orientation. The OECD Teaching and Learning International Study (TALIS; OECD 2009) of practicing teachers produced similar results.

5 Summary

If one tries to summarize the main aspects we learned from TEDS-M, there are methodological and substantive aspects to be mentioned. TEDS-M showed that studies in the field of higher education are challenging and difficult to do. Several levels of aggregation are to be considered—and each one has its own benefits and limits. From a substantive point of view, we learned that achievement in different domains of teacher knowledge (MCK, MPCK, GPK) can differ a lot. And the achievement of teachers from different programs within a country can differ a lot as well. Here, we can learn the most for policy efforts within countries to improve the effectiveness of a system. Overall, teacher knowledge does not seem to be an exclusive function of societal features, of features of incoming students or of the length, the structure or the content of teacher education only but a complex amalgam of these characteristics. Complex and detailed analyses will shed more light on these issues in the following chapters.

References

Alexander, R. (2001). *Culture and Pedagogy: international comparisons in primary education*. New York/Oxford: Wiley/Blackwell Sci.

Baumert, J., & Kunter, M. (2006). Stichwort: Professionelle Kompetenz von Lehrkräften. *Zeitschrift für Erziehungswissenschaft*, *9*, 469–520.

Blömeke, S. (2002). *Universität und Lehrerausbildung*. Bad Heilbrunn: Klinkhardt.

Blömeke, S. (2012a). Content, professional preparation and teaching methods: how diverse is teacher education across countries? *Comparative Education Review*, *56*(4), 684–714.

Blömeke, S. (2012b). Does greater teacher knowledge lead to student orientation? The relationship between teacher knowledge and teacher beliefs. In J. König (Ed.), *Teachers‘ pedagogical beliefs: Definition and operationalisation—Connections to knowledge and performance—Development and change* (pp. 15–35). Münster: Waxmann.

Blömeke, S., & Kaiser, G. (2012). Homogeneity or heterogeneity? Profiles of opportunities to learn in primary teacher education and their relationship to cultural context and outcomes. *ZDM – The International Journal on Mathematics Education*, *44*(3), 249–264.

Blömeke, S., & Paine, L. (2008). Getting the fish out of the water: considering benefits and problems of doing research on teacher education at an international level. *Teaching and Teacher Education*, *24*(4), 2027–2037.

Blömeke, S., Kaiser, G., & Lehmann, R. (Eds.) (2010a). *TEDS-M 2008: Professionelle Kompetenz und Lerngelegenheiten angehender Primarstufenlehrkräfte im internationalen Vergleich*. Münster: Waxmann. (Cross-national comparison of the professional competency of and learning opportunities for future primary school teachers).

Blömeke, S., Kaiser, G., & Lehmann, R. (Eds.) (2010b). *TEDS-M 2008: Professionelle Kompetenz und Lerngelegenheiten angehender Mathematiklehrkräfte für die Sekundarstufe I im internationalen Vergleich* [Cross-national comparison of the professional competency of and learning opportunities for future secondary school teachers of mathematics]. Münster: Waxmann.

Blömeke, S., Felbrich, A., Müller, Ch., Kaiser, G., & Lehmann, R. (2008). Effectiveness of teacher education. State of research, measurement issues and consequences for future studies. *ZDM – The International Journal on Mathematics Education*, *40*(5), 719–734.

Blömeke, S., Suhl, U., & Kaiser, G. (2011). Teacher education effectiveness: quality and equity of future primary teachers' mathematics and mathematics pedagogical content knowledge. *Journal of Teacher Education*, *62*(2), 154–171.

Blömeke, S., Suhl, U., Kaiser, G., & Döhrmann, M. (2012). Family background, entry selectivity and opportunities to learn: what matters in primary teacher education? An international comparison of fifteen countries. *Teaching and Teacher Education*, *28*, 44–55.

Boyd, D., Grossman, P. L., Lankford, H., Loeb, S., & Wyckoff, J. (2009). Teacher preparation and student achievement. *Educational Evaluation and Policy Analysis*, *31*(4), 416–440.

Clotfelter, C., Ladd, H., & Vigdor, J. (2007). *Teacher credentials and student achievement in high school: A cross-subject analysis with student fixed effects*. Cambridge: National Bureau of Economic Research.

Cochran-Smith, M., & Zeichner, K. M. (Eds.) (2005). *Studying teacher education. The report of the AERA panel on research and teacher education*. Mahwah: Lawrence Erlbaum.

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Hillsdale: Lawrence Erlbaum.

Constantine, J., Player, D., Silva, T., Hallgren, K., Grider, M., Deke, J., & Warner, E. (2009). *An evaluation of teachers trained through different routes to certification* (NCEE 2009-4043). Washington, DC: IES.

Dionne, J. J. (1984). The perception of mathematics among elementary school teachers. In J. M. Moser (Ed.), *Proceedings of the 6th Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 223–228). Madison: University of Wisconsin-Madison.

Dubberke, T., Kunter, M., Julius-McElvany, N., Brunner, M., & Baumert, J. (2008). Lerntheoretische Überzeugungen von Mathematiklehrkräften: Einflüsse auf die Unterrichtsgestaltung und den Lernerfolg von Schülerinnen und Schülern. *Zeitschrift für Pädagogische Psychologie*, *22*, 193–206.

Ernest, P. (1989). The impact of beliefs on the teaching of mathematics. In P. Ernest (Ed.), *Mathematics Teaching. The State of the Art* (pp. 249–254). New York: Falmer Press.

Ferrini-Mundy, J., Floden, R., McCrory, R., Burrill, G., & Sandow, D. (2005). *A conceptual framework for knowledge for teaching school algebra*. East Lansing, MI: Authors.

Furinghetti, F., & Morselli, F. (2009). Leading beliefs in the teaching of proof. In W. Schlöglmann & J. Maasz (Eds.), *Beliefs and Attitudes in Mathematics Education: New Research Results* (pp. 59–74). Rotterdam: Sense Publishers.

Goldhaber, D., & Liddle, S. (2011). *The gateway to the profession. Assessing teacher preparation programs based on student achievement* (CEDR Working Paper 2011-2). Seattle, WA: University of Washington.

Goldin, G., Rösken, B., & Törner, G. (2009). Beliefs—no longer a hidden variable in mathematical and learning processes. In W. Schlöglmann & J. Maasz (Eds.), *Beliefs and Attitudes in Mathematics Education: New Research Results* (pp. 1–18). Rotterdam: Sense Publishers.

Goos, M., Stillman, G., & Vale, C. (2007). *Teaching Secondary Mathematics. Research and Practice for the 21st Century*. London: Allen & Unwin.

Grigutsch, S., Raatz, U., & Törner, G. (1998). Einstellungen gegenüber Mathematik bei Mathematiklehrern. *Journal für Mathematik-Didaktik*, *19*, 3–45.

Hill, H. C., Ball, D. L., & Schilling, S. G. (2008). Unpacking pedagogical content knowledge: conceptualising and measuring teachers' topic-specific knowledge of students. *Journal for Research in Mathematics Education*, *39*(4), 372–400.

Hofstede, G. (2001). *Culture's Consequences—Comparing Values, Behaviors, Institutions and Organizations Across Nations*. Thousand Oaks: Sage.

Hradil, St. (2001). *Soziale Ungleichheit in Deutschland (8. Aufl.)*. Opladen: Leske + Budrich.

Kaiser, G., Hino, K., & Knipping, C. (2006). Proposal for a framework to analyse mathematics education in Eastern and Western traditions. In K.D. Graf, F. Leung, F. Lopez-Real (Eds.), *Mathematics Education in Different Cultural Traditions—a Comparative Study of East Asia and the West* (pp. 319–351). New York: Springer.

Krauss, S., Brunner, M., Kunter, M., Baumert, J., Blum, W., Neubrand, M., et al. (2008). Pedagogical content knowledge and content knowledge of secondary mathematics teachers. *Journal of Educational Psychology*, *100*(3), 716–725.

Leder, C., Pehkonen, E., & Törner, G. (Eds.) (2002). *Beliefs: A hidden variable in mathematics education?* Dordrecht: Kluwer Academic.

Leinhardt, G., & Greeno, G. (1986). The cognitive skill of teaching. *Journal of Educational Psychology*, *78*(2), 75–95.

Leung, F. K. S., Graf, K.-D., & Lopez-Real, F. J. (2006). Mathematics education in different cultural traditions: a comparative study of East Asia and the West. In F. K. S. Leung, K.-D. Graf, & F. J. Lopez-Real (Eds.), *Mathematics Education in Different Cultural Traditions. A Comparative Study of East Asia and the West. The 13th ICMI Study* (pp. 1–20). New York: Springer.

Leung, F. K. S. (2001). In search of an East Asian identity in mathematics education. *Educational Studies in Mathematics*, *47*(1), 35–51.

Liljedahl, P., Rolka, K., & Roesken, B. (2007). Affecting affect: the reeducation of preservice teachers' beliefs about mathematics and mathematics teaching and learning. In W. G. Martin, M. E. Strutchens, & P. C. Elliott (Eds.), *The Learning of Mathematics. Sixty-Ninth Yearbook of the National Council of Teachers of Mathematics* (pp. 319–330). Reston: National Council of Teachers of Mathematics.

McDonald, J. P. (1992). *Teaching: Making sense of an uncertain craft*. New York: Teachers College Press.

McDonnell, L. M. (1995). Opportunity to learn as a research concept and a policy instrument. *Educational Evaluation and Policy Analysis*, *17*(3), 305–322.

Mullis, I. V. S., Martin, M. O., & Foy, P. (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: TIMSS & PIRLS International Study Center, Boston College.

National Council of Teachers of Mathematics (NCTM) (2000). *Principles and standards for school mathematics*. Reston: NCTM.

NOKUT [Nasjonalt Organ for Kvalitet i Utdanningen] (2006). Evaluering av Allmennlærerutdanningen i Norge 2006. Hovedrapport. http://www.nokut.no/Documents/NOKUT/Artikkelbibliotek/Norsk_utdanning/SK/alueva/ALUEVA_Hovedrapport.pdf.

NRC (2010). *Preparing teachers: Building evidence for sound policy*. Washington: National Academies Press.

OECD (2009). *Creating Effective Teaching and Learning Environments. First Results from TALIS—Teaching and Learning International Survey*. Paris: OECD.

Op 't Eynde, P., De Corte, E., & Verschaffel, L. (2002). Framing students' mathematics related beliefs. A quest for conceptual clarity and a comprehensive categorization. In G. C. Leder, E. Pehkonen, & G. Törner (Eds.), *Beliefs: A hidden variable in mathematics education?* (pp. 13–37). Dordrecht: Kluwer Academic.

Peterson, P. L., Fennema, E., Carpenter, T., & Loef, M. (1989). Teachers' pedagogical content beliefs in mathematics. *Cognition and Instruction*, *6*(1), 1–40.

Richardson, V. (1996). The role of attitudes and beliefs in learning to teach. In J. Sikula, T. Buttery, & E. Guyton (Eds.), *Handbook of research on teacher education* (2nd edn.) (pp. 102–119). New York: Macmillan Co.

Rowland, T., & Ruthven, K. (Eds.) (2011). *Mathematical Knowledge in Teaching*. Dordrecht: Springer.

Schilling, S. G., Blunk, M., & Hill, H. C. (2007). Test validation and the MKT measures: generalizations and conclusions. *Measurement: Interdisciplinary Research and Perspectives*, *5*(2–3), 118–127.

Schmidt, W., Houang, R., Cogan, L., Blömeke, S., Tatto, M. T., Hsieh, F. J., et al. (2008). Opportunity to learn in the preparation of mathematics teachers: its structure and how it varies across six countries. *ZDM - The International Journal on Mathematics Education*, *40*(5), 735–747.

Schmidt, W. H., Blömeke, S., & Tatto, M. T. (2011). *Teacher education matters. A study of the mathematics teacher preparation from six countries*. New York: Teachers College Press.

Schoenfeld, A. H. (1998). Toward a theory of teaching-in-context. *Issues in Education*, *4*(1), 1–94.

Shulman, L. (1985). Paradigms and research programs in the study of teaching: A contemporary perspective. In M. C. Wittrock (Ed.), *Handbook of research on teaching* (3rd edn.) (pp. 3–36). New York: Macmillan Co.

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

Stark, J., & Lattuca, L. R. (1997). In *Shaping the college curriculum: Academic plans in action*, Boston: Allyn & Bacon.

Staub, F., & Stern, E. (2002). The nature of teacher's pedagogical content beliefs matters for students' achievement gains: quasi-experimental evidence from elementary mathematics. *Journal of Educational Psychology*, *94*, 344–355.

Tatto, M. T., Schwille, J., Senk, S., Ingvarson, L., Peck, R., & Rowley, G. (2008). *Teacher education and development study in mathematics (TEDS-M): Policy, practice, and readiness to teach primary and secondary mathematics. Conceptual framework*. East Lansing, MI: Teacher Education and Development International Study Center, College of Education, Michigan State University.

Tatto, M. T., Schwille, J., Senk, S. L., Ingvarson, L., Rowley, G., Peck, R., et al. (2012). *Policy, practice, and readiness to teach primary and secondary mathematics in 17 countries. Findings from the IEA Teacher Education and Development Study in Mathematics (TEDS-M)*. Amsterdam: IEA.

Thompson, A. G. (1992). Teachers' beliefs and conceptions: A synthesis of research. In D. A. Grouws (Ed.), *Handbook of research on mathematics teaching and learning* (pp. 127–146). New York: Macmillan Co.

Tobin, J. J., Wu, D. Y. H., & Davidson, D. H. (1989). *Preschool in three cultures: Japan, China, and the United States*. New Haven: Yale University Press.

Tobin, J. J., Hsueh, Y., & Karasawa, M. (2009). *Preschool in three cultures revisited: China, Japan, and the United States*. Chicago: University of Chicago Press.

Travers, K. J. & Westbury, I. (Eds.) (1989). *The IEA study of mathematics I: Analysis of mathematics curricula*. Oxford: Pergamon.

UNESCO (1997). *International standard classification of education—ISCED*. Paris: UNESCO.

UNICEF (1999). *Women in Transition. The MONEE Project Regional Monitoring Report No. 6*. Florenz: UNICEF.

Vollrath, H.-J. (2001). *Grundlagen des Mathematikunterrichts in der Sekundarstufe*. Heidelberg: Spektrum.

Voss, T., Kleickmann, T., Kunter, M., & Hachfeld, A. (2011). Überzeugungen von Mathematiklehrkräften. In M. Kunter, J. Baumert, W. Blum, U. Klusmann, S. Krauss, & M. Neubrand (Eds.), *Professionelle Kompetenz von Lehrkräften – Ergebnisse des Forschungsprogramms COACTIV*, Münster: Waxmann (pp. 235–258).

Weinert, F. E. (2001). Concepts of competence: A conceptual clarification. In D. S. Rychen & L. H. Salgnik (Eds.), *Defining and selecting key competencies* (pp. 45–66). Göttingen: Hogrefe & Huber.

Wilson, S. M., Floden, R. E., & Ferrini-Mundy, J. (2001). *Teacher preparation research. Current knowledge, gaps, and recommendations*. Washington: Center for the Study of Teaching and Policy.

http://www.springer.com/978-94-007-6436-1

International Perspectives on Teacher Knowledge,
Beliefs and Opportunities to Learn
TEDS-M Results
Blömeke, S.; Hsieh, F.-J.; Kaiser, G.; Schmidt, W.H. (Eds.)
2014, IX, 592 p. 132 illus., Hardcover
ISBN: 978-94-007-6436-1