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INTRODUCTION TO THIS SPECIAL ISSUE

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Preparing and educating high-quality mathematics and science teachers is a crucial challenge internationally in the twenty-first century as these subjects can be regarded as decisive for the future of our societies. However, the structure and the content of teacher education depend on a deeper rationale, which is often a result of cultural boundaries. From a national point of view, such cultural givens are at risk to remain invisible but they emerge through the lens of international comparisons (Blömeke & Paine, 2008). Many components or factors in mathematics and science teacher education cannot be understood without an international perspective, such as what counts as responsive and effective teacher education, what counts as appropriate teaching, or what are country-specific strengths and weaknesses. A clearer and deeper understanding of these issues through comparative studies is necessary for policy makers to establish appropriate educational policies and practices and for scholars to generate twenty-first century research and practice of mathematics and science teacher education.

At the same time, cross-country variations in teacher education can increase the difficulty in understanding the specifics of teacher growth during teacher education. Confounding cultural influences or differences in institutional and program settings between countries may bias the results about development of mathematics and science teachers during teacher education including the effects of opportunities to learn (OTL). In such cases, differences in teacher knowledge or teacher beliefs may well be the function of a mix of broader influences and the future teachers' OTL. Therefore, if we are interested in examining development, it may be wise to restrict ourselves to one context.

This Special Issue of IJSME attempts to combine these two perspectives by examining the practice and the results of mathematics and science teacher education from an international point of view on the one hand and by examining the development of future mathematics and science teachers during teacher education from a longitudinal point of view on the other hand. The two parts of the Special Issue comprise one that includes cross-sectional comparative studies on the achievement of future mathematics and science teachers from different countries and another that includes (quasi-)longitudinal studies in one country.

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The following key components and their relationship are covered in both parts of the Special Issue: teacher knowledge and teacher beliefs, OTL and their impact on teacher knowledge and teacher beliefs, the role of school context characteristics for the development of teacher knowledge, and teacher beliefs during their first years in the profession.

Part I: Cross-Country Comparisons of Teacher Education Outcomes

Blömeke, Suhl, and Döhrmann examine influences of the cultural context on future mathematics teachers' content and pedagogical content knowledge at the end of teacher education by detecting and explaining differential item functioning (DIF) in 16 countries based on data from the Teacher Education and Development Study in Mathematics (TEDS-M; Tatto, Schwille, Senk, Bankov, Rodriguez, Reckase, Ingvarson, et al., 2012). As hypothesized, content domains, cognitive demands (including item difficulty), and item format significantly explain variance in DIF. Country pairs show similar patterns in the relationship of DIF to these item characteristics: future teachers from Taiwan and Singapore are particularly strong on mathematics content and constructed-response items, future teachers from Russia and Poland are particularly strong on items requiring non-standard mathematical operations, and the USA and Norway do particularly well on mathematics pedagogical content and data items. Thus, conditional on the countries' mean performance, the knowledge profiles of the future teachers match the respective national debates.

Hsieh, Wong, and Wang elaborate these results on cultural similarities and differences in more detail with respect to future secondary mathematics teachers from Taiwan and Singapore as countries integrating the Chinese/Confucian tradition in their educational systems. Based on Niss' framework of mathematics competence, the study shows that Singaporean future teachers are less strong in devising formal mathematical arguments and transforming heuristic ideas into valid proofs when compared to Taiwanese future teachers. Compared to high-achieving Western countries, the strengths of future teachers from both countries occur particularly with respect to mathematics related to primary, lower- or upper-secondary levels whereas the teachers reveal relative weaknesses at the tertiary level.

These results are more deeply elaborated by Wang and Tang. Based on TEDS-M data, they examine the OTL of future secondary mathematics teachers from 15 countries, which may explain such variation in teacher education outcomes. Following an approach developed by Blömeke &

Kaiser (2012), dominating OTL profiles across and within countries with respect to tertiary-level mathematics, school-level mathematics, mathematics education, and general education are identified. The study reveals that secondary teacher education requires mostly an extensive coverage of mathematics topics whereas primary teacher education appears to be characterized by two peaks. The preparation philosophies in mathematics and general education are widely homogeneous at both levels.

Cañadas, Gómez, and Rico add to this examination by exploring the structure of the by-now widely neglected primary mathematics teacher education in one country, namely Spain, based on data collected from 48 institutions that participated in TEDS-M. They focus on the content reported by teacher educators in their syllabi and structure it into four domains: school mathematics, advanced mathematics, general pedagogy, and mathematics pedagogy. The results reveal that Spanish teacher education programs are diverse across institutions but follow a basic structure that emphasizes the teaching of general pedagogy subjects.

Laschke brings these approaches together by examining the relationship between future secondary mathematics teachers' knowledge and their affective, cognitive, and sociodemographic characteristics while controlling for their OTL. The study is based on the Taiwanese and German sample of TEDS-M and uses multilevel modeling. The results reveal that teacher knowledge in Germany is more strongly affected by future teachers' individual characteristics than teacher knowledge in Taiwan. Laschke interprets the results against the background of cultural differences between "the West" and "the East" or "individualism" and "collectivism," respectively.

Hsieh discusses the conceptual frameworks underlying such measurements in international comparison studies, in particular with respect to mathematics pedagogical content knowledge (MPCK). Two large-scale comparative assessments, Mathematics Teaching in the Twenty-First Century (MT21; Schmidt, Blömeke, & Tatto, 2011) and TEDS-M (Tatto et al., 2012) are used as reference studies. The challenges faced by these included the lack of elaborate conceptual frameworks for MPCK developed by non-Western scholars and the test items tied to these frameworks. Hsieh introduces a new MPCK conceptual framework developed specifically for an Asian context (Hsieh, 2012). The items of MT21 and TEDS-M are then reexamined according to this model. Distinct or even conflicting ideas between Taiwanese and Western countries regarding the scope and substance of different types of mathematics teachers' knowledge are revealed. Hsieh's model is, thus, a start toward searching for an East Asian "identity" of MPCK.

Part II: a Longitudinal Examination of Teacher Growth during Teacher Education and Induction

Buchholtz and Kaiser report about the design and the results of a longitudinal study on the effectiveness of innovative mathematics teacher education programs aiming at improving secondary teacher education by restructuring its entry phase. The first year of these programs seems to be decisive for study success as many countries experience a high dropout rate during that time. The development of the future teachers' knowledge in university mathematics, in school mathematics knowledge from an advanced point of view, and in MPCK from innovative programs is compared to the outcomes of traditional university programs. The study reveals that innovative programs only partially succeed and that knowledge growth needs certain support conditions.

Markic and Eilks present a study of future teachers' beliefs about teaching and learning chemistry at different stages of their teacher education. They examine 3 cohorts of first year university students, future teachers midway through their program, and recently graduated teachers. Their results indicate change during teacher education from traditional beliefs about teaching and learning characterized by teacher-centeredness and an understanding of learning as receptive consumption toward more modern beliefs about teaching and learning in line with modern educational theory.

König presents a longitudinal study on teacher education with respect to how it fosters future teachers' theoretical and practical knowledge of general pedagogy. The data are based on testing a group of future teachers at the beginning, after 2 years, and at the end of their teacher education program. Findings show that the more advanced these future teachers are in the course of their initial teacher education, the better they perform in this test measuring general pedagogical knowledge (GPK). When analyzing subscales of the test measuring cognitive dimensions of GPK, as would be expected, declarative-conceptual knowledge was gained predominantly during the first years whereas future teachers who had additionally passed practical experiences performed better on the practical knowledge test subscale.

Blömeke and Klein examine the transition from preservice teacher education into the profession. Their hypothesis was that the more support beginning mathematics teachers perceive and the better they evaluate the management of their school, the higher their teaching quality. Indicators of teaching quality were how the teachers, who were in their third year in the profession, regarded themselves able to cope with the challenges of mathematics instruction and generic tasks like classroom management and how satisfied they were with their job. Indicators of support were the level of

appraisal and autonomy the teachers reported. School management indicators were the administrative leadership of the principal and the climate of trust as perceived by the teachers. The results, in fact, reveal that teacher support played an important role in the quality of these teachers. All quality indicators improved significantly when beginning teachers reported more appraisal and autonomy. A climate of trust played an important role for the extent of autonomy perceived. Administrative leadership was significantly related to the amount of appraisal the teachers reported. These results provide important information on how to steer a school so that the quality of beginning mathematics teachers is maximized.

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