Learning from the Eastern and the Western Debate—The Case of Mathematics Teacher Education

Gabriele Kaiser and Sigrid Blömeke

Abstract Comparative studies have gained significant influence in the last decades, and school systems of many countries have been revised referring to better results of other countries in international large-scale assessments. Authors of such studies commonly link their interpretations of the results to distinctions between "Eastern" and "Western" cultures, in particular with respect to the consistent and continuing outstanding performance of East Asian learners compared with their Western counterparts. One question is whether the same achievement pattern holds for future teachers and whether similar cultural difference may cause it. IEA's "Teacher Education and Development Study in Mathematics" (TEDS-M) was the first comparative study that focused on the outcomes of teacher education with standardised testing. In this paper—based on the TEDS-M results—commonalities and differences in the achievement of future teachers from Eastern and Western countries are explored and related to a cultural perspective. Cultural differences between Eastern and Western approaches concerning mathematics, mathematics education and mathematics teachers are analysed with respect to the achievement pattern. The paper closes with reflections on possible consequences concerning the development of teachers' knowledge and teachers' expertise in mathematics education.

Keywords Culture in education · Cultural differences · Mathematics learning · Mathematics teachers · Effectiveness of teacher education · International study · Comparative study · Teacher expertise · East Asia

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1 Introduction: Cultural Differences and Their Influence on Education

Comparative studies have gained significant influence in the last decades and have influenced reforms of educational systems around the world. School systems of many countries have been revised referring to better results of other countries in international large-scale assessments. Authors of such studies commonly link their interpretations of the results to distinctions between "Eastern" and "Western" cultures, in particular with respect to the consistent and continuing outstanding performance of East Asian learners compared to their Western counterparts. According to this work, mathematics education in "Eastern" and "Western" cultures can be characterised by sharp distinctions, amongst others the acquisition of basic knowledge (East) versus creativity (West).

One question is whether, in fact, there exists such a joint characterisation of students from East Asian countries, who are assumed to represent what is called the "Eastern" culture, as distinct from a joint characterisation of students from European or English-speaking countries, assumed to represent what is called the "Western" culture.

Leung (2001) described in his "search of an East Asian identity in mathematics education" important differences between the East Asian and the Western traditions in mathematics education using strong dichotomies. Firstly, he distinguished between "product (content) versus process". According to him, in East Asian mathematics classrooms mathematics content and procedures or skills are emphasised putting basic knowledge and basic skills in the foreground, whereas Western education in the last decades has tended to focus more on the process of doing mathematics. Secondly, Leung (2001) distinguished between rote learning versus meaningful learning, with rote learning and memorisation as a legitimate and necessary way of learning, contributing to a better understanding, as seen in East Asian countries. In contrast, Western cultures emphasised the necessity of understanding the phenomenon before it can be memorised and internalised. Studying hard versus pleasurable learning was presented as the third dichotomy. It refers to traditional views in East Asian countries that studying is a serious endeavour relying on hard work and perseverance, in contrast to many Western views, which put the child in the middle of the learning process, and who has to enjoy the meaningful learning process.

The fourth dichotomy presented by Leung (2001), "extrinsic versus intrinsic motivation", described that on the motivational level Western educators value intrinsic motivation in learning mathematics more than extrinsic motivation. In contrast, their Eastern counterparts emphasise the necessity of extrinsic motivation as complementary to intrinsic motivation, reflecting the high relevance of high-stake tests. The fifth dichotomy corresponded to a different understanding of the nature and the role of the teacher, which is based on social orientations in East Asian countries. Whole-class teaching with the teacher as the role model is regarded as highly important in East Asian countries, in contrast to the stronger focus on individualised learning in Western countries, stressing the independence and individualism within learning. The sixth dichotomy developed by Leung (2001) referred again to a different understanding of the role of the teacher, namely as a scholar with profound subject-matter knowledge in East Asian countries compared to the teacher as a facilitator with profound pedagogical competencies in the West.

Summarising, Leung (2001) sees the core differences between East Asian and Western views on mathematics education in different views on "who or what the centre in the teaching and learning process should be" (p. 47)—student-centred education in Western approaches, in contrast to a tripartite emphasis on the student, the teacher and the subject matter in East Asian cultures. Leung (2001) hypothesized that this tripartite description of teaching and learning might be the essence of an East Asian identity, which is in line with other approaches, for example with the concept of learning in the Confucian Heritage Culture (CHC). Wong (2004) described as a central feature of learning based on the CHC its orientation towards social or collective achievement, in contrast to an orientation towards individual achievement in Western cultures—including an emphasis on diligence, an attribution of success to effort, a competitive spirit, and a high relevance of practice (Wong 2004).

Although Confucianism seems to have a strong influence on education, it has to be taken into account that there is no direct connection or causal relationship between schools of thought and social phenomena such as high achievements of students in mathematics, as Wong et al. (2012) pointed out. Nevertheless, there seems to be some consensus that a kind of joint identity of East Asian learning traditions exists. Whether there is a common core of Western educational traditions seems to be more controversial.

The ICMI Study "Mathematics Education in Different Cultural Traditions—A Comparative Study of East Asia and the West" (Leung et al. 2006) contrasted the "Chinese/Confucian tradition" with the "Greek/Latin/Christian tradition". Recent studies on European traditions in pedagogy emphasise its diversity. In particular, a difference between approaches coming from the United Kingdom on the one hand and from the Scandinavian countries and Continental Europe, including Belgium and the Netherlands, on the other hand is stressed, with the first approach characterised by pragmatically oriented ways of teaching and learning and the second approach sharing a joint didactics tradition (Hudson and Meyer 2011).

Such a didactics tradition is virtually unknown in the English-speaking world and is distinct from curriculum traditions prominent there (Blömeke and Paine 2008). As Hudson and Meyer (2011) pointed out, the historical origin of present-day didactics dates back to Jan Amos Comenius and his work *Didactica Magna* (Great didactic), developed in the 17th century within the framework of the Age of Enlightenment, in which he claimed to teach everything thoroughly to everybody, emphasising the necessity of carefully laid out teaching sequences based on general principles.

Referring specifically to mathematics education, several studies have pointed out that there are relevant differences in the teaching and learning traditions between Anglo-Saxon and Continental European traditions concerning the kind of mathematical knowledge to be acquired, the role of argumentation and proof and the kind of interactional activities (Kaiser 2002; Kaiser et al. 2006; Pepin 1999). However, focusing on the differences between East Asian cultures and Western cultures as elaborated above, the Western approaches seem to have more in common with each other than with the Eastern approach, such as in putting the individual in the foreground. This means that, in fact, we can assume a joint identity of students from East Asian countries distinct from a joint identity of students from European or English-speaking countries.

This distinction can be explained with theories from cultural psychology or sociology, amongst others the famous cultural-psychological framework developed by Hofstede (1986, 2001). Departing from a definition of culture as the "shared motives, values, beliefs, identities, and interpretations or meanings of significant events that result from common experiences of members of collectives that are transmitted across generations" (House et al. 2004, p. 15), Hofstede (1986) concluded that through socialisation processes a country's culture has an impact on the preferred modes of learning. Within the framework of Hofstede (1986), the collectivism-individualism dimension refers to the extent to which the individuals of a society are perceived as autonomous. This criterion seems to be particularly relevant in explaining differences between East Asian and Western teaching and learning processes. We will elaborate details of this framework within the interpretation of TEDS-M results in Sect. 3.3.

Turning to the achievement level, it is striking that all international comparative studies of the last decades, such as TIMSS, originally implemented by the International Association for the Evaluation of Educational Achievement (IEA) in 1995, or the OECD PISA studies, carried out since 2000 in three-year cycles, reveal a similar picture, namely the students from the five East Asian countries outperforming all students from Western countries with a substantial gap in average mathematics achievement between these five Asian countries and the next group of countries.

For example, in TIMSS 2011, Singapore, South Korea and Hong Kong, followed by Chinese Taipei and Japan, were the top-performing countries at fourth grade followed after a great gap by Northern Ireland and then after another gap Belgium, Finland, England, the Russian Federation, the USA and the Netherlands. Similarly, at eighth grade, South Korea, Singapore and Chinese Taipei outperformed all countries, followed by Hong Kong and Japan; after a huge gap Russia was listed followed by Israel, Finland and the USA (Mullis et al. 2012). PISA 2009, in which 65 countries participated, showed similar results with the students from Shanghai-China, Singapore, Hong Kong, South Korea and Chinese Taipei achieving the best results in mathematics followed by students from Finland, Switzerland, Japan, Canada, the Netherlands, New Zealand and Australia. German students performed above the international mean and the USA students below (OECD 2010, 130ff).

This well-documented outstanding mathematics achievement of East Asian students compared to their Western counterparts has been studied in detail with case studies and complementary studies accompanying TIMSS in 1995. Based on data from these studies, Kawanaka et al. (1999) stated: "Although there probably are many ideas in the Japanese videos that could prove useful in the classrooms in other countries, systems of teaching are not easily transported from one culture into another" (p. 103). Following this statement, the question emerges: What, in fact, can we learn from international comparative studies then? In particular: Can the Eastern and the Western traditions of mathematics education learn from each other? In order to answer these questions we analyse in the following the intentions and the development of comparative studies in the past. Afterwards we will use the "Teacher Education and Development Study in Mathematics" (TEDS-M) as an example of an international comparative study, in which we discuss the differences between Eastern and Western traditions from a cultural perspective.

2 Intentions and Historical Development of Comparative Education

An overall consensus exists that international comparative studies provide insight into other educational systems and support a better understanding of one's own educational system (Blömeke and Paine 2008). Stigler and Perry (1988) emphasised such a potential of comparative studies: "Cross cultural comparison also leads researchers and educators to a more explicit understanding of their own implicit theories about how children learn mathematics. Without comparison, we tend not to question our own traditional teaching practices and we may not even be aware of the choices we have made in constructing the educational process" (p. 199).

However, it is difficult to compare educational systems based on different cultures, different philosophical traditions, different values and other different characteristics. This difficulty is reflected in two famous characterisations of comparative education. Thut and Adams (1964) described comparative education as indispensable: "To study education well is to study it comparatively" (Back Cover). Husén—a founding member of the IEA and chair of the First International Mathematics Study (FIMS)—specified in contrast the limitations of comparative education: "Comparing the outcomes of learning in different countries is in several respects an exercise in comparing the incomparable" (1983, p. 455).

Bringing these problems together, Postlethwaite (1988) defined in his seminal work in the *Encyclopedia of Comparative Education and National Systems of Education* what comparative education actually means: "Strictly speaking, to 'compare' means to examine two or more entities by putting them side by side and looking for similarities and differences among them. In the field of education, this can apply both to comparisons between and comparisons within systems of education" (p. xvii). Comparative education in Postlethwaite's perspective would have to focus on similarities *and* differences between *and* within educational systems, to seek for patterns in the differences or similarities, which then allow deeper insights into the various systems.

Postlethwaite pointed out that such an understanding of comparative studies on education has a long history in Europe, going back as far as the ancient times of Greeks or Romans, and in medieval times to Marco Polo's travel to China or Alexis de Tocqueville's work. For Europe the studies by Sir Michael Sadler are of special importance. Sadler visited the Prussian folk school system at the beginning of the 20th century together with a British expert commission and compared it with the British educational system. In his ground-breaking article "How Far Can We Learn Anything of Practical Value from the Study of Foreign Systems of Education" (Sadler 1964, originally published 1900), Sadler analysed the gap between the educational systems of continental Europe and England. He described the high achievement of the German educational system, a decisive factor in which was, for Sadler, the strong national interest in education within Germany. He therefore proposed to send future teachers at the end of their study to Germany in order "to study … its methods of teaching and system of education" (Sadler 1964, p. 310).

However, Sadler was also sceptical of some aspects of the German school system and to what extent its characteristics could be transferred to England. He stated that it was a common misbelief "that all other nations have better systems of education than we have. It is a great mistake to think, or imply, that one kind of education suits every nation alike" (Sadler 1964, p. 312). He therefore recommended enhancing the English school system by accepting the good aspects of the English system and by learning from the continental European school systems. He formulated the following caveat against simply transferring single components or measures of foreign educational systems into one's own system, often still quoted today:

> In studying foreign systems of Education we should not forget that the things outside the schools matter even more than the things inside the schools, and govern and interpret the things inside. We cannot wander at pleasure among the educational systems of the world, like a child strolling through a garden and pick off a flower from one bush and some leaves from another, and then expect that if we stick what we have gathered into the soil at home, we shall have a living plant. A national system of education is a living thing, the outcome of forgotten struggles and 'of battles long ago'. It has in it some of the secret workings of national life. (p. 310)

In the aftermath, researchers attempted to identify those factors influencing the development of school systems using methods from social sciences. The limitations of comparative education however lie, as Hilker (1962) pointed out, in the missing normative potential of these studies, which cannot create the norms of education and an educational philosophy out of itself. Which actions to take based on the *tertium comparationis*, which is needed as a benchmark for the initial objective, can only be decided outside comparative education.

Summarising these different issues it becomes clear that, on the one hand, comparative education is looking for general patterns and mutual understanding of various educational systems. On the other hand it is obvious that comparisons cannot result in far-reaching recommendations for the change of educational systems. The cultural dependency of comparative education presents simultaneously an opportunity and a problem, though as Alexander (1999) phrases it:

> I argue that the educational activity which we call pedagogy—the purposive mix of educational values and principles in action of planning, content, strategy and technique, of learning, and assessment, and of relationships both instrumental and affective—is a window on the culture of which it is a part,

> and on that culture's underlying tensions and contradictions as well as its publicly-declared educational policies and purposes. Second, like many others these days I argue that the comparative perspective is an important and necessary part of the quest to understand and improve the science, art or craft of teaching, and to enable us to distinguish those aspects of teaching which are generic and cross international boundaries from those which are culture-specific. (p. 149)

Returning to the current international debate on mathematics education, we argue that despite the rich database created in the many international comparative studies, the core questions of these studies' relevance and potential consequences still remain unresolved. Alexander (1999, p. 158) called this the "the 'so what?' problem in educational research", calling for cultural sensitive studies with practical insight.

We intend to offer at least some first answers to these questions. Based on TEDS-M, we analyse cultural influences on the teacher's role and function, especially with respect to teacher knowledge. Is the gap in K-12 student achievement valid for future or practising teachers as well? Does, in fact, a vicious cycle of competent students and competent teachers exist, as Leung and Park (2002) describe it on the basis of case studies? We discuss then what the East and the West potentially can learn from each other.

3 TEDS-M: An International Comparative Study on Teacher Education

Criticism about the inefficiency of teacher education has long been voiced in many Western countries. Teacher education has been described as a weak intervention compared to one's own school experience and later professional socialisation (Richardson 1996). Particularly referring to mathematics teacher education, Klein (1905) criticised more than 100 years ago in his famous metaphor of a "double discontinuity" the lack of impact of university education on teaching practice in school. Such criticisms of teacher education stimulated the implementation of a study about the effectiveness of teacher education carried out under the auspices of the IEA, TEDS-M, whose results were released in 2010 (see in particular Blömeke et al. 2011; Tatto et al. 2012; various papers in *ZDM* 2012, 44(3) and all papers in Blömeke et al. 2014).

3.1 Background and Theoretical Framework of TEDS-M

TEDS-M comprised a primary study and a lower-secondary study with 15 countries participating in each study, covering Eastern and Western countries. The focus of TEDS-M was future teachers in their final year of teacher education who would receive a licence to teach mathematics in either grades 1 through 4 (primary study) or grade 8 (lower-secondary study). The two studies were based on nationally representative samples and had to follow the rigorous IEA quality control mechanisms of sampling, data collection, coding and data analysis. The research questions of TEDS-M were multi-layered, namely:

1. What are the professional competencies of future mathematics teachers?
2. How distinctive are the institutional conditions of mathematics teacher education?
3. What are the national conditions of mathematics teacher education?

In this paper we concentrate on the first research question, the professional competencies of future teachers. According to Weinert (2001), professional competencies can be divided into cognitive facets (in our context, teachers' professional knowledge) and affective-motivational facets (in our context, professional beliefs).

The professional knowledge of teachers can again be divided into several facets. Referring to the seminal work by Shulman (1986), the following facets were distinguished in TEDS-M: mathematics content knowledge (MCK), mathematics pedagogical content knowledge (MPCK) including curricular knowledge, and general pedagogical knowledge (GPK). These facets of professional knowledge were further differentiated: MCK covered the main mathematical areas relevant for future teachers, while MPCK covered curricular knowledge, knowledge of lesson planning and interactive knowledge applied to teaching situations (see Fig. 1). The framework has similarities to models of professional knowledge developed in other studies (see Blömeke and Delaney 2012 for a detailed overview).

TEDS-M also examined the professional beliefs held by the future teachers, due to the fact that beliefs are crucial for the perception of classroom situations and for decisions on how to act, as Schoenfeld (2011) pointed out. Based on Richardson (1996), beliefs can be defined as stable, psychologically held propositions of the world around us, which are accepted to be true. In TEDS-M, several belief facets were distinguished, in particular epistemological beliefs about the nature of mathematics and beliefs about the teaching and learning of mathematics (Thompson 1992).

TEDS-M examined mathematics teacher education using a broad range of instruments. Due to our focus on future teachers, we restrict ourselves to the survey that covered the background of the future teachers, their opportunities to learn in teacher education, their knowledge of mathematics, mathematics pedagogy and general pedagogy, their beliefs on mathematics, the teaching and learning of mathematics, and schooling.

3.2 Selected Results from TEDS-M

Due to space restrictions, we present only selected results of the primary study (for details of the lower-secondary study see Blömeke et al. 2010; and in particular Blömeke et al. 2014). The evaluation of the future primary teachers' achievement

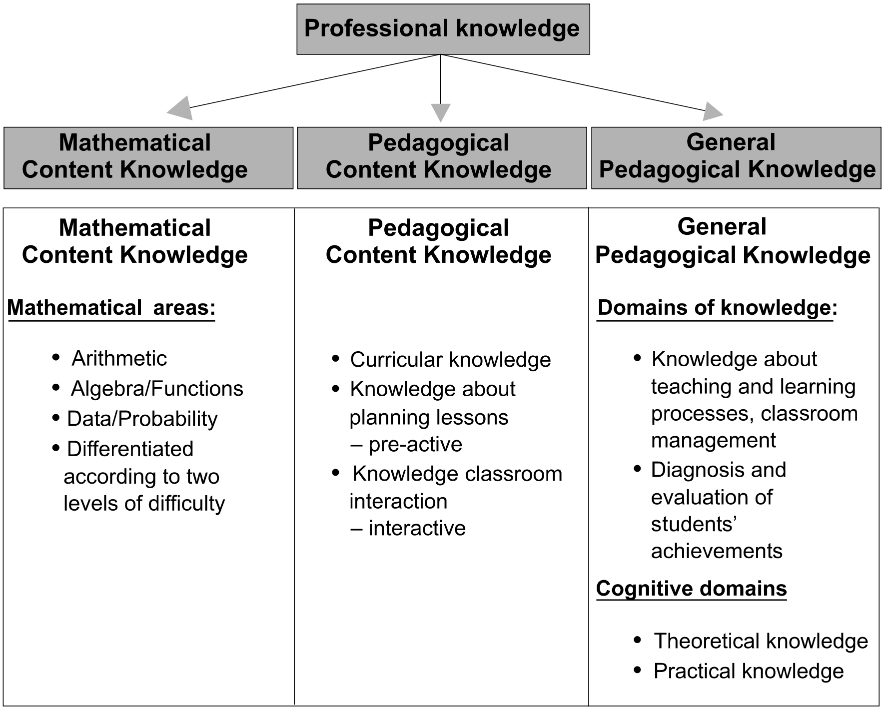

Fig. 1 TEDS-M model of professional knowledge (Tatto et al. 2008)

revealed huge differences between the participating countries concerning both MCK and MPCK. The participants from Taiwan and Singapore showed the highest performance, which was significantly distinct from the performance of the other participating countries. The future teachers from the USA and Germany were hardly above the international mean of 500 points, the difference of these from the achievement of future teachers from Taiwan and Singapore being about one standard deviation. The achievement of future teachers from the USA and Germany was not only lower than that of the future East Asian teachers, it was also significantly lower than the achievement of future teachers from Switzerland. Relating the achievement to the Human Development Index, we can point out that future teachers from Russia and Thailand showed a surprisingly good performance (Table 1).

Concerning MPCK, the performance pattern was quite similar: the future primary teachers from Singapore and Taiwan achieved much higher test results than the future teachers from the other countries. The German students' attainments were around the international mean, with their difference from Singapore and Taiwan again being about one standard deviation. In addition, the MPCK results from the German students were significantly lower than those from Switzerland, the USA and Norway.

A comparison of the relative strengths and weaknesses in MPCK and MCK highlights interesting differences. Country-specific profiles emerge which may reflect

Table 1 MCK and MPCK of future primary teachers by country

Mathematics Content Knowledge of Future Primary Teachers		Mathematics Pedagogical Content Knowledge of Future Primary Teachers	
Country	Mean (S.E.)	Country	Mean (S.E.)
Taiwan	623 (4.2)	Singapore	593 (3.4)
Singapore	590 (3.1)	Taiwan	592 (2.3)
Switzerland[a]	543 (1.9)	Norway[d,f]	545 (2.4)
Russia	535 (9.9)	USA[c,d,e]	544 (2.5)
Thailand	528 (2.3)	Switzerland[a]	537 (1.6)
Norway[d]	519 (2.6)	Russia	512 (8.1)
USA[c,d,e]	518 (4.1)	Thailand	506 (2.3)
Germany	510 (2.7)	Malaysia	503 (3.1)
International	500 (1.2)	Germany	502 (4.0)
Poland[b,d]	490 (2.2)	International	500 (1.3)
Malaysia	488 (1.8)	Spain	492 (2.2)
Spain	481 (2.6)	Poland[b,d]	478 (1.8)
Botswana	441 (5.9)	Philippines	457 (9.7)
Philippines	440 (7.7)	Botswana	448 (8.8)
Chile[d]	413 (2.1)	Chile[d]	425 (3.7)
Georgia	345 (3.9)	Georgia	345 (4.9)

[a]Colleges of Education in German speaking regions

[b]Institutions with concurrent programs

[c]Public Universities

[d]Combined Participation Rate <75 %

[e]High proportion of missing values

[f]Results for Norway are reported by combining the data sets available in order to present a proxy of the country mean

the orientation and cultural traditions of teacher education in general and mathematics teacher education in particular. The following analyses of these orientations with mathematics teacher education will allow us to develop our argumentation of what the Eastern and the Western debate can enable us to learn from each other. Based on Fig. 2, we can identify three groups:

- Higher achievement in MCK than in MPCK—from Asia, the future teachers from Taiwan and Thailand belong to this group; from Eastern and Central Europe the future teachers from Russia, Poland, Germany and Switzerland also belong to this group.
- Higher achievement in MPCK than in MCK—several Eastern and Western countries belong to this group, namely the future teachers from Norway, the USA, Spain, Chile, Malaysia and the Philippines.

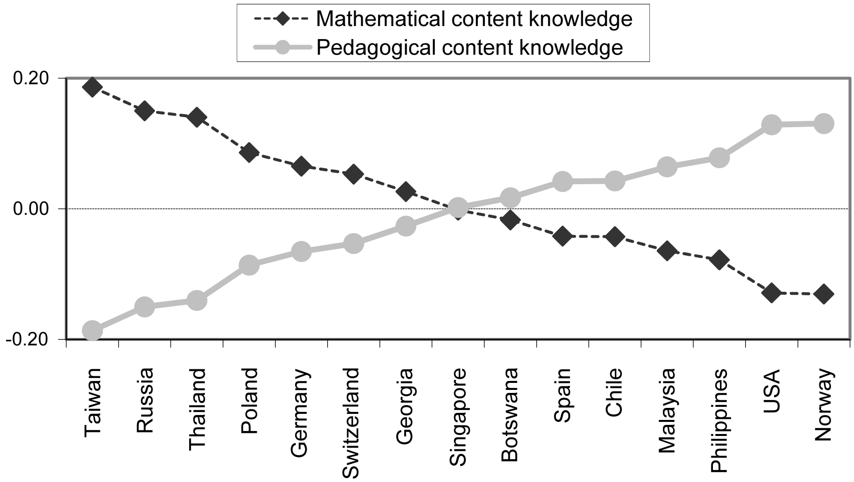

Fig. 2 Country-specific profiles of MCK and MPCK of future primary teachers

- Nearly equal level—one East Asian country, namely Singapore, and one country from the former Soviet Union, namely Georgia, belong to this group as well as the only participating African country, Botswana.

The profiles of the three groups are independent of the absolute level of achievement. Countries with higher-achieving future teachers can be found in both groups, e.g. Taiwan or Norway. The same holds for lower-achieving countries. Even the two East Asian countries belong to different groups with Singapore playing an intermediate role. The results show that apparently no "silver bullet" to high achievement in both domains exists. Neither a strong emphasis on MCK nor on MPCK seems to promote the overall achievement of the future teachers of a country.

However, a deeper analysis of the different profiles points to an influence of cultural traditions, which may have shaped the profiles. As cultural explanations, the following lines of discussion are brought forward. Influenced by the CHC tradition, the teacher is seen as an expert in many East Asian countries. The teacher is the "scholar-teacher" (Leung 2006; Li and Huang 2013) who inherits the content knowledge students need to acquire. Such a tradition leads, amongst other things, to a high importance of content knowledge in teacher education.

But content knowledge does not only play a significant role in mathematics teacher education in East Asia. In Continental Europe, content-related approaches place traditionally high priority on knowledge in the already mentioned tradition of didactics. With respect to the field of mathematics, this approach includes didactical reflections on the teaching of mathematics based on a sound and deep understanding of mathematics content as background knowledge. In the German tradition, several researchers have brought forward this position (Griesel 1974) and influenced the European tradition on didactics. The broad notion of "pedagogical content knowledge" in Continental Europe compared to English-speaking countries strongly emphasises theory-guided knowledge closely connected to the content. Didactics in this sense (Pepin 1999) is characterised by its inseparable connection of content knowledge and teaching knowledge.

Finally, Eastern European countries have historical roots linked to the German educational systems, including teacher education (Alexander 2000). Content knowledge and content-related didactics are therefore important, too. These traditions may have supported the achievement patterns displayed in Fig. 2, namely a relatively high level of MCK compared to MPCK of the future teachers from East Asian and Eastern European countries and Germany and Switzerland, which may reflect the high emphasis of content in teacher education.

The situation is quite different in Scandinavian countries, North and South America and in countries shaped by a US influence such as the Philippines (Nebres 2006). In this tradition, a so-called "progressive education" with child-centred approaches characterises K-12 education and teacher education. The child is in the foreground, whereas the content is assigned a background role. In addition, the English-speaking countries share as already mentioned a tradition of pragmatism, assigning content knowledge less importance than pragmatic reflections (Kaiser 2002). These traditions may have in turn supported the achievement patterns displayed in Fig. 2, namely a relatively high level of MPCK compared to MCK of the future teachers from Scandinavian, American and South-East Asian countries.

Such cultural influences on the results of TEDS-M cannot only be seen at the achievement level, but also in the area of the future teachers' beliefs. TEDS-M has evaluated in detail epistemological beliefs on the nature of mathematics and on the genesis of mathematical knowledge, i.e. the nature of mathematics teaching and learning (for details see Felbrich et al. 2012). Four fundamental views on mathematics were distinguished (Grigutsch et al. 1998), which can be grouped into two overarching perspectives on mathematics: a formalism-related and a scheme-related view characterise mathematics as a static science; whereas a process-related and an application-related view conceptualise mathematics as a dynamic process.

Based on relative analyses—in which the mean of all items measuring beliefs on the nature of mathematics were subtracted from the agreement to each single belief item ("ipsative score", that is, the agreement is corrected for the overall tendency of a future teacher to agree; OECD 2009)—three groups of countries can be distinguished (see Fig. 3). In the first group of countries, future teachers followed relatively strongly a dynamic orientation in their view on mathematics. These were mainly European countries, including Germany, Switzerland and Norway. Another group followed relatively strongly a static orientation. These future teachers came from South-East Asian and East European countries including Russia and Thailand. A balanced view was held by future teachers from East Asian countries including Taiwan and Singapore and Western countries including Spain and the USA.

Similar tendencies concerning beliefs on the genesis of mathematical knowledge can be identified, namely a particularly strong dominance of constructivist approaches, which were hold mainly by future teachers from Western European countries and Taiwan. In contrast, a relative dominance of transmission-oriented approaches was put forward by future teachers from Eastern European countries and

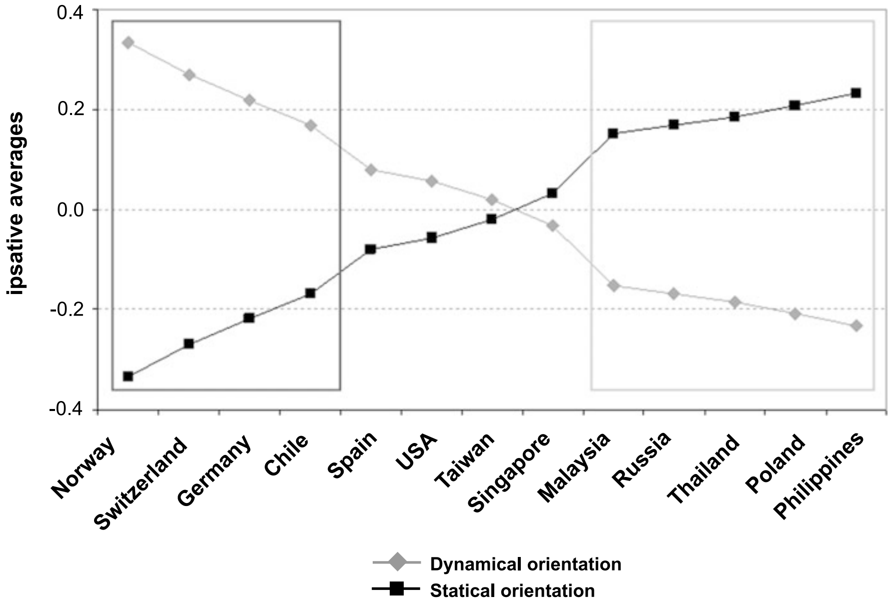

Fig. 3 Country-specific profiles of future primary teachers' beliefs on the nature of mathematics

South-East Asian countries such as Malaysia (see Fig. 4). Again, a middle group existed with countries including the USA and Spain.

3.3 First Interpretations of These TEDS-M Results

Not all of these TEDS-M results were in line with our expectations. Indeed, some of them came rather unexpectedly. The following first interpretations refer to cultural-psychological and mathematics historical approaches.

During the debate on beliefs and their influence on teaching and learning, Schoenfeld (1998) pointed out that beliefs can be understood as socially and culturally shaped mental constructs, which are acquired in educational settings with different historical traditions that vary significantly between countries. The already mentioned cultural-psychological framework of Hofstede (1986) seems to be adequate to offer explanations for the differences between countries in the beliefs on the nature of mathematics, namely the distinction between collectivism versus individualism.

The collectivism-individualism dimension refers to the extent to which the individuals of a society are seen as autonomous, and societal action is consequently seen as a result of freely negotiated contracts. Transferred to education—which is done in the work by Triandis (1995)—this means that in individualistic-oriented countries students are seen as autonomous subjects, who are not obliged to learn

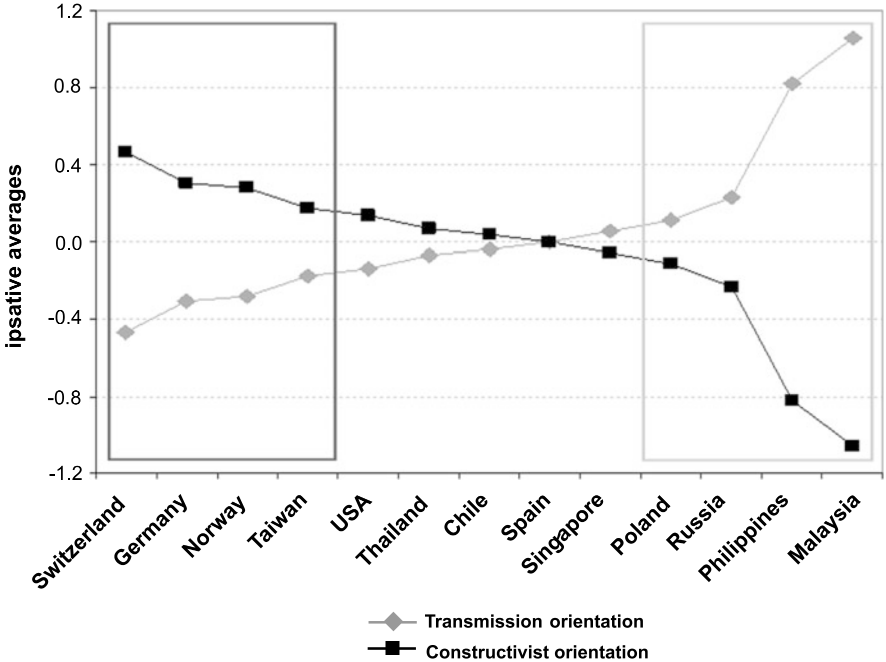

Fig. 4 Country-specific profiles of future primary teachers' beliefs on the genesis of mathematical knowledge

for familial or societal reasons. Failure in achievement is consequently attributed to context conditions inadequately addressing the individual student's needs, such as too difficult tasks, poor lessons or poor explanations by the teachers, rather than to characteristics of the learner such as lack of effort or talent. The required measures to change the situation refer to the context conditions such as improving the quality of the lessons or the school system, and seldom to obliging the individual student to put more effort into his or her learning.

In contrast, in collectivistic countries the role of social relationships in general and for the acquisition of knowledge is more prominent. In collectivistic countries, societal actions are seen as commitment towards social networks. Transferred into education, this means that student learning is seen as a commitment towards their teachers, their families and the society. Failing in school is attributed to a lack of effort, learners not engaging enough in learning processes. The required action to take is to put more effort into school because of an inner obligation.

In Hofstede's approach, additional distinctions in the teacher-student as well as in the student-student interaction exist between individualistic and collectivistic countries, which again may explain the distinction in the future teachers' beliefs. In individualistic societies, students would expect to learn how to learn and to think, whereas in collectivistic societies the focus is on passing the many high-stakes examinations. This latter approach may be connected to a more schematic view on mathematics whereas students from individualistic societies may have more chances to work on mathematical investigations.

Studies on learning styles from cross-cultural psychology substantiate these first interpretations. Several comparative studies found systematic variation in learning styles depending on the cultural background (for an overview see Yamazaki 2005). Learners from individualistic societies showed a preference for abstract conceptualisation as well as for active experimentation in learning. With respect to mathematics these learners should then also prefer a process-oriented and application-oriented and thus dynamic view, where mathematics is thought of as a process and used as a tool for problem solving. Learners from collectivistic-oriented societies on the other hand showed a preference for concrete experiences in learning as well as for reflective observation. This may predispose them to take a scheme and formalism related and thus static view of mathematics.

Finally, referring to the distinction between algorithmic mathematics as a tool for the solution of problems and dialectic mathematics as a logical science focused on the examination of the truth of statements, introduced by Henrici (1974) and based on historical studies, Siu (2009a, 2009b) describes different views on mathematics in Western and Eastern countries. He elaborates that practical-algorithmic views on mathematics prevailed in Asian countries due to their relation to the old Egyptian, Chinese and Indian mathematics; in contrast to Western countries, where dialectic-theoretical views on mathematics were dominant, influenced by their origin in the classical Greek mathematics. These differences correspond with the high importance of astronomy in old China, which has influenced the development of mathematics significantly (Martzloff 2000).

However, Siu (2009a, 2009b) also points to the fact that due to the westernisation and opening up of Asian societies to Western influences, mathematics education has also incorporated Western ideas about mathematics. Consequently, nowadays both the dynamic and the static views on mathematics, or in Henrici's terminology dialectic and algorithmic views on mathematics, are incorporated into their beliefs by Asian teachers. This corresponds with empirical findings by Leung (2006), who was able to show that teachers in Beijing more often agree with the static-algorithmic character of mathematics than teachers from London, who more often held a dynamic-heuristic view concerning mathematics. In contrast, views of teachers from Hong Kong, who are influenced by both Eastern and Western perspectives, were located in between the two groups.

To summarise, these descriptions point to an important characteristic of mathematics, namely the so-called Janus-faced or dual character of mathematics, incorporating complementarily both dynamic and static aspects. This characteristic is reflected amongst others in the theoretical approach by Sfard (1991) describing the interplay of operational and structural phases in concept development as of crucial importance. Based on these approaches, different dichotomies currently important in Eastern and Western views on mathematics, such as procedural versus conceptual knowledge and process versus object, can be integrated into a more comprehensive framework.

Large-scale research on the impact of such cultural expectations on the formation of beliefs related to the teaching and learning of mathematics in individualistic and collectivistic countries has only been developed in the last decade. The results of TALIS, the "Teaching and Learning International Survey" (OECD 2009) which examined practising teachers' epistemological beliefs on the teaching and learning of mathematics, pointed in the same direction as TEDS-M. In TALIS, the cultural patterns in beliefs were identified for the first time (OECD 2009; Vieluf and Klieme 2011). Similar results were revealed by the MT21 Study "Mathematics Teaching in the 21st Century" (Schmidt et al. 2011).

These results can be used to interpret the results of TEDS-M concerning the beliefs of future mathematics teachers on the genesis of mathematical knowledge. In individualistic countries such as Germany or Norway, constructivist principles of teaching and learning are dominant, which put the individual student into the foreground. In collectivistic countries such as Russia or the Philippines, transmission aspects are prevalent, with teachers being seen to be responsible for the transfer of knowledge to students.

4 Cultural Lenses on Teacher Education and Teacher Expertise

To answer our opening question, what the Eastern and the Western debate enables us to learn from each other, it can be hypothesized that our thinking about teachers and their knowledge is influenced by the cultural differences between Eastern and Western countries identified above. In their international overview on expertise in mathematics education, Li and Kaiser (2011) pointed out that many commonalities in the conceptions of teacher expertise exist in Eastern and Western countries. However, significant differences between Eastern and Western approaches on expertise could also be identified.

Eastern approaches put teachers' instructional practices in the foreground and specify teachers' knowledge as part of their expertise in a more holistic way. Consequently, teacher knowledge is described within the frame of teachers' instructional practices, and is not taken as a stand-alone component. Rather, it is taken as an integrated aspect of what teachers are capable of doing. Therefore there is no uniform position within the Eastern debate: different approaches are common in the various East Asian countries such as joint lesson studies, joint textbook analysis, apprenticeship practices and public lessons within the context of contests or master teachers who serve as role models (see Li and Huang 2013).

In contrast, contributions from the West likely examine and analyse teacher knowledge as an important yet stand-alone aspect of teacher expertise. Teacher expertise is regarded in an analytical way as containing different components, including knowledge, beliefs and teaching performance, which becomes obvious within the TEDS-M framework. Such differences in describing teacher expertise point to the influence of cultural orientations, distinguishing the Eastern from the Western debate.

This difference in conceptualising teacher expertise may also be linked to the unspoken difficulty of identifying expert teachers. This difficulty may pose a bigger challenge to researchers in the West than in the East, as teaching is regarded as a private practice in the West but not in the East (Kaiser and Vollstedt 2007). Thus, researchers in the West take a more theoretically driven approach to conceptualising teacher expertise, in contrast to the East, where it is possible to first identify those teachers and then to analyse their characteristics.

Other notable differences between East and West may be manifested in the various roles assigned to expert teachers. Russ et al. (2011) developed four metaphors of expertise:

- role of teachers as *diagnosticians*, describing the teachers' ability to interpret student thinking and students' problem solving strategies;
- role of teachers as *conductors*, leading the classroom discourse and establishing classroom norms for the communication about mathematical ideas;
- role of teachers as *architects*, identifying cognitively demanding tasks;
- role of teachers as *river guides*, deciding how to unfold the lesson as it progresses based on intuition and improvisation'.

This description of expertise clearly focuses on the learning process and the individual student teacher's organisation of learning processes in order to promote student learning.

A comparison with the different aspects of expertise from an Eastern perspective shows remarkable differences. Yang (2014) in his study on expert teachers in China identifies multiple roles which have to be played by an expert teacher:

- role as a *teacher* means structuring good teaching processes;
- role as a *researcher* means carrying out research on teaching and publishing papers in professional and academic journals;
- role as a *teacher educator* means serving as a mentor of non-expert teachers and promoting non-expert teachers' professional development;
- role as a *scholar* means disposing of profound knowledge in mathematics and other areas;
- role as an *examiner* means possessing the ability to pose high-quality examination problems;
- role as a *model* means to serve as an example for students and colleagues.

Similar descriptions were developed by Li et al. (2011) in their study on expert teachers. They point out that expert teachers are expected to serve as moral role models who stand for culturally valued moral characteristics and expertise for others to follow. In addition, they emphasise the necessity for an expert teacher to act as a researcher and to regularly write books and scientific papers in teacher journals published by many East Asian universities focusing on teacher education.

Taking into account the "closed-door policy" of many Western schools, the request to act within public and exemplary or teaching contests up to the national level makes the Eastern approach to defining expertise quite different from Western conceptions. In addition, the teacher promotion system, commonly practised in several East Asian countries, provides a platform for teachers to value and pursue mathematics classroom instruction excellence. Yang (2014) emphasises that in contrast

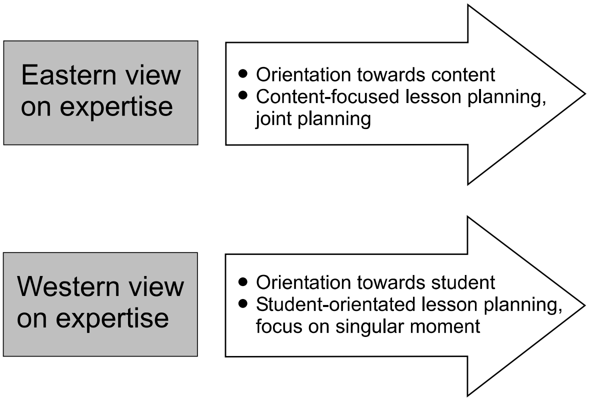

Fig. 5 Cultural perspective on teacher expertise

to Western culture, where the closed-door policy is followed, teaching in China is open for colleagues' observations, studies and discussions, mainly based in teaching research groups.

Kaiser and Li (2011) describe therefore the "Eastern perspective on teacher expertise as more holistic, aiming for a systemic change of the teaching-and-learning processes in school by strengthening teachers as researchers and developing expertise in scientific work" (p. 349). They emphasise that this holistic view is embedded in a public value of expert teachers who work not only on their teaching but also on curriculum development. According to Kaiser and Li (2011), the Western perspective is in contrast "clearly focused on the teaching-and-learning process within the classroom, where experienced teachers shall display their expertise especially in interactions with the students. Characteristic for the Western approach to expertise is the focus on the individual student, who is put into the centre of reflections and actions; the promotion of learning processes of individual students is a major goal of the classroom activities" (p. 349).

The differences in the cultural perspectives on the understanding of teacher expertise between Eastern and Western approaches are summarised in Fig. 5.

The already introduced cultural-psychological distinction of collectivistic and individualistic countries may once again allow explaining, at least partly, the differences in the understanding of teacher expertise. The strong holistic orientation on expertise in Eastern countries may be based on the collectivistic orientation of the countries, which may result in a professional development that refers to whole teacher groups, including curricular work aiming for systemic change. The individualistic orientation of Western cultures, in contrast, expects the single teacher to provide effective learning environments and good classroom management and may therefore describe expertise as a focus on individual student learning.

Cai et al. (2009) confirmed such an interpretation from the teachers' perspective on effective mathematics teaching. Based on their research work, they described Asian teachers as mathematics content-oriented, and they emphasized that an effective teacher should understand the content thoroughly and organise teaching in well-structured lessons. In contrast, teachers from the USA and Europe tended to

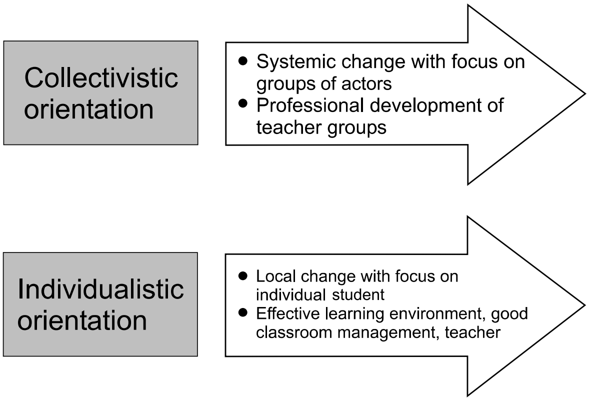

Fig. 6 Cultural perspectives on educational change

be more child-oriented, emphasising that an effective teacher should be passionate about mathematics, and leave enough room and time for students to develop an understanding of mathematics on their own.

These different perspectives on teacher knowledge and teacher expertise based on cultural differences of collectivism and individualism have significant consequences when it comes to possible indicators of change. Within the Eastern tradition, the focus of the indicators is at the systemic level, on groups of actors and their professional development. In contrast, indicators in the West refer to changes on the local level, putting the individual teacher and his/her ability to develop effective learning environments and manage the classroom effectively in the foreground. This characterisation is, for example, reflected in Hattie's (2012) recommendations for effective teaching based on the results of his synthesis of meta-analyses mainly from English-speaking countries.

To sum up, cultural differences concerning the description of expertise in mathematics education are visible in the different ways of implementing expertise and in the ways of attempting change in mathematics education (see Fig. 6).

We would like to close with a tentative conclusion coming back to Michael Sadler's original question posed in 1900: "How far can we learn anything of practical value from the study of foreign systems of education?" If one takes into account the cultural dependency of educational processes and the thinking of major players within these systems, who are not only teachers, but also students, parents and policy makers, it becomes obvious that it is not appropriate simply to take isolated measures from another educational system such as special teaching materials, teaching methods or teaching contests without questioning the context of these measures. Thus, the transfer of a single measure will not bring change. The full paradigm of teacher knowledge connected to the spirit of the underlying educational philosophy needs to be taken into account to accomplish any sustainable educational change.

From the perspective of the accelerating internationalisation of education at all levels, and the globalisation of nearly all societal processes, the Eastern and Western debate enables both to learn from each other. Both traditions need to pay attention to the individual student and his or her learning processes, to the content of mathematics as the base of learning, and to a combination of local and systemic measures for changing teacher education and teacher effectiveness. Effective teaching-and-learning environments may have different shapes in different countries but valuing teachers, supporting student learning and putting education in the foreground for a comprehensively educated human being will be the key for good mathematics education in all parts of the world (Zhao 2005).

International comparative studies have the potential to reveal an unbalanced view of one's own culture on mathematics (cf. dialectic or algorithmic), show collectivistic and individualistic ways of organising teaching-and-learning processes, and define adequate teacher and student behaviour. At the end of the day, they can provide insight into the possibilities to complement and enrich our own view on education. Individualism may be a benefit when it comes to creativity, as we know from studies on business organisations (Goncalo and Staw 2006). Why Western, in particular US, companies are so innovative is explained this way (Kanter 1988). East Asian countries may want to learn from such approaches without losing their strong cognitive base. In contrast, Western countries may want to learn from the East Asian motivation to strive hard for educational success without losing their creative base.

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