Common tasks of teaching as a resource for measuring professional content knowledge internationally

MARK HOOVER, REIDAR MOSVOLD AND JANNE FAUSKANGER

In the United States, extensive time and money has been invested in developing and validating measures of mathematical knowledge for teaching (MKT). Although studies of adaptation of these measures generally conclude that they are useable in other countries, cultural differences in teaching prompt questions about whether theories and measures of knowledge for teaching are culturally specific. This article argues that the issue turns on the meaning of "teaching" and "tasks of teaching" and it recommends increased efforts to identify professionally defensible mathematical tasks of teaching that can serve as a common foundation for conceptualizing and measuring mathematical knowledge for teaching internationally.

Almost three decades ago, Shulman (1986) launched renewed interest in teachers' professional knowledge among education researchers. Following Shulman, Ball and her colleagues created a practice-based theory of mathematical knowledge for teaching (MKT) (see e.g. Ball, Thames & Phelps, 2008). In addition to conceptualizing MKT, they created and validated measures of MKT (Hill, Rowan & Ball, 2005; Schilling & Hill, 2007).

As a doctoral student in this research group, Delaney (2008) translated, adapted and implemented several of these MKT measures for use in Ireland (see also Delaney, Ball, Hill, Schilling & Zopf, 2008). A recent special issue of ZDM (Blömeke & Delaney, 2012) reports on similar studies conducted in other countries. These studies describe numerous challenges, but suggest an overall picture of successful adaptation.

Adapting geometry items, Ng (2012) identifies subtleties in the use of mathematical language between the Indonesian and U.S. contexts, as well as differences in sample populations that make psychometric comparability difficult (such as in teachers' training related to

Mark Hoover, *University of Michigan*
Reidar Mosvold, *University of Stavanger*
Janne Fauskanger, *University of Stavanger*

Hoover, M., Mosvold R. & Fauskanger, J. (2014). Common tasks of teaching as a resource for measuring professional content knowledge internationally. *Nordic Studies in Mathematics Education*, 19 (3-4), 7–20.

different mathematical topics). Despite these challenges, Ng finds the overall integrity of the measures adequate for revealing such issues. In their Norwegian project, Fauskanger, Jakobsen, Mosvold and Bjuland (2012) also report that the measures function well overall. They identify ways in which changes in language and context can influence responses to items and discuss potential sources of these influences. In their discussion of results from a study adapting the measures for use in South Korea, Kwon, Thames and Pang (2012) suggest that changes might have to be made to particular items in order to fit with specific cultural contexts. However, based on cognitive interviews and psychometric analysis, their main conclusion is that such instances are exceptions rather than the rule. Along the same lines, Cole (2012), who adapted the measures for use in Ghana, concludes that they can be productively used, but with attention to ways that teaching practice varies across countries.

Although providing evidence that adaptations can be viable, the studies above also acknowledge a counter argument, initially introduced by Delaney (2008) and restated as follows: 1) teaching is a cultural activity (e.g. Stigler & Hiebert, 1999); 2) given that the MKT construct and measures are based on studies of U.S. teaching, they may be related to – even limited to – a U.S. teaching culture; 3) if so, then the mathematical knowledge needed to teach might be different from country to country; and, as a result, 4) the use of MKT measures in other countries may be problematic. To evaluate this argument – which focuses on potential cultural differences in teaching practice – it is helpful to consider the underlying concepts of *work of teaching* and *tasks of teaching* used in MKT assessment items and to ask whether, or to what extent, such concepts, as defined therein, are meaningful across cultural contexts.

In what Ball and Bass (2003) designate as a practice-based theory of MKT, the work of teaching refers to core tasks that teachers need to execute to help pupils learn. They refer to the identification of such tasks as a kind of "job analysis" that aims to characterize what needs to get done at a level above specifics of how one might go about accomplishing the work. Mathematical tasks of teaching, then, are those activities of the work of teaching that are distinctly mathematical, as in figure 1.

We suggest that the idea of common tasks of teaching – that represent a decomposition of the work of teaching into professionally recognizable components – constitutes a potential foundation for an internationally useful practice-based theory of MKT and associated set of measures. Our main purpose with this theoretical article (making a conceptual argument) is to provide readers with a critical discussion about whether and how common tasks of teaching can be a resource for measuring professional content knowledge internationally. To our knowledge, researchers

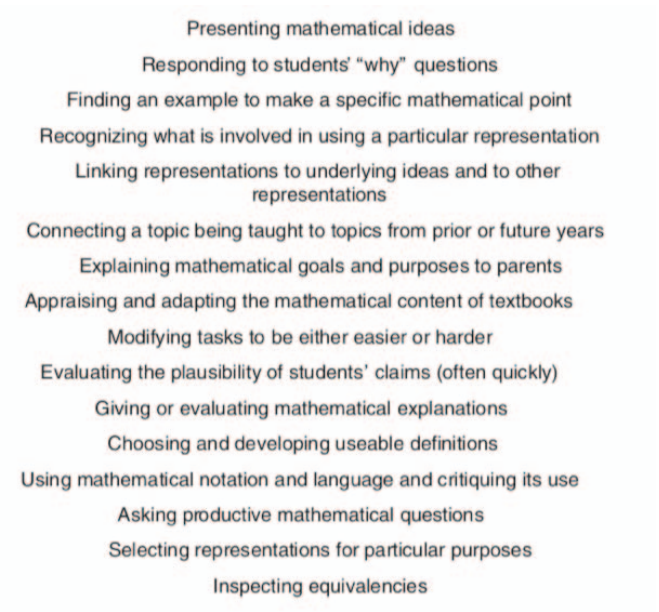

Figure 1. *Example mathematical tasks of teaching mathematics (Ball et al., 2008, p. 400)*

in the field have not discussed the idea of identifying common tasks of teaching for the purpose of building a body of professional knowledge internationally.

For this article we assume that MKT matters and that the research community needs to invest in building a body of professional knowledge. We argue that the development of internationally shared measures of MKT is a useful focus for such work and that "common tasks of teaching mathematics" need to be identified to support such an effort. In particular, we argue that a focus on building a shared understanding of tasks of teaching would contribute to building a professional knowledge base by combining judgment and ongoing collection of empirical evidence. Doing so would support the development of measures and models crucial to studying impact and setting policy.

We first sketch highlights from studies that explore the cultural situatedness of teaching and review assumptions, meaning and purpose related to the concept of MKT. We then discuss how the construct of tasks of teaching can be used to provide a common foundation for conceptualizing and measuring MKT in different cultures.

Teaching as a cultural activity

Based on an international comparison of teaching, Stigler and Hiebert (1999) argue that teaching is a cultural activity. LeTendre, Baker, Akiba, Goesling and Wiseman (2001) refer to this as a national-culture perspective and contrast it with a global-dynamic-cultural perspective. It is hard to argue against Stigler and Hiebert's claim that teaching is a cultural activity – and this is not our intent. Certainly, their characterization of teaching as a cultural activity raises questions about the portability of a practice-based theory and measures based on it. However, the implication is not straightforward.

In a preceding study, Stevenson and Stigler (1992) found differences among teaching observed in Japanese, Chinese and American schools. One example concerned how teachers responded differently to students' errors. They argue that, although there are cultural differences in how teachers approach challenges in teaching, the challenges as such are strikingly similar across cultures. They discuss activities of using concrete representations, responding to errors effectively, providing students with time to think, managing diversity and introducing a problem. In their study, although cultural differences in how teachers approached these challenges were significant (when seen from a national-culture perspective), the challenges as such were similar.

In the final report from the TIMSS 1999 Video Study, Hiebert and colleagues (2003) found differences in teaching inside as well as across countries. They do not directly discuss the idea of teaching as cultural activity, but they question the idea of country-specific scripts of teaching. When investigating classroom practices in Seoul, Shanghai and Tokyo, Xu and Clarke (2013) found similarities as well as differences. Based on their findings, they suggest that approaches to identify some universal criteria for teacher competence will not be successful. In apparent contrast with this, Hiebert, Gallimore and Stigler (2002) call for the development of a more common "knowledge base for the teaching profession." They suggest that more general, practice-based theories of teacher knowledge must be developed, and such theories, they argue, need to be closely connected to teachers' practice. As Gallimore and Stigler (2003) argue, knowledge for teaching is useful when it is "developed in response to specific problems of practice" and "is linked with practice by being grounded in the context in which teachers work and aligned to the content that they are required to teach" (p. 28). The point here is that professional knowledge, to the extent that it is effective, which is a hallmark of professional knowledge, must be grounded in the demands of the work, not simply a reflection of cultural responses to those demands.

We suggest that a possible explanation for the seemingly diverging arguments presented above lies in the conception of teaching. On the

one hand, teaching can be viewed as management of instructional interactions that are co-constructed by students and teacher around content. As such, teaching can share a very general framing that emanates from the underlying endeavor of helping groups of students learn content. On the other hand, there is a view of teaching as a cultural practice, where the role and meaning of schooling is a cultural artifact and where teaching practice is a byproduct of specific, cultural forces. If one subscribes to the latter view, it makes sense to argue that it is not fruitful to try to identify common criteria for professional teacher knowledge. If subscribing to the former view, however, such attempts make sense.

Of course, both perspectives are true to a certain extent. Teaching is to some degree a professional activity defined by the effort to support students' learning of content. Teaching is also to some degree a cultural activity that provides an organization of social life defined by the forces of culture and cultural reproduction. However, in aiming to identify and grow a professional knowledge base for teaching – viz. a premise of our argument – we suggest that a view of teaching as defined by the work of managing instructional interaction provides a helpful frame.

Assumptions, meaning and purpose in the development of MKT

A number of assumptions, or orientations, underlie the practice-based approach developed by Ball's research group, in particular specific understandings of: 1) the role of the discipline of mathematics in and for teaching; 2) the meaning of the term "teaching" in the phrase "for teaching"; and 3) the mutual importance of both conceptual work and the validation of proposed conceptualizations in advancing early-stage research.

Ball and Wilson (1996) argue that there must be a dual commitment in teaching that respects the thinking students do and the disciplines being represented. Rooted in this understanding of teaching, a disciplinary perspective has been central to methods for analyzing teaching and to the conceptualization of MKT (Ball & Bass, 2003). A mathematical perspective can illuminate the mathematics entailed in classroom instruction and can provide framing for the mathematical work of teaching.

Another important orientation shaping research on MKT is a particular understanding of the term teaching. In this work, teaching is seen as a *plausible* conception of *professional* practice, where the meanings of "plausible" and "professional" are key. The defining character of a profession is that there is a body of shared, technical knowledge and language (cf. Lortie, 1975). The defining character of a professional practice is that practitioners agree on ways of specifying and evaluating the identified activity. Given that no such agreement currently exists, a practice-based approach to the study of MKT needs to bootstrap conceptions of

responsible practice that might realistically stand up to collective vetting by practitioners. The approach of Ball's research group has been to propose conceptions of responsible practice based on analysis of records of practice with the goal of then identifying what is entailed mathematically in that teaching (Ball et al., 2008).

A third orientation is evident in the research design and methods employed. Given that research on MKT is still in early stages of development, the focus has been on the conceptual framing of questions and the development of conceptual tools. Ball's conceptual-analytic research aims to develop meaningful concepts grounded in the examination of data from different, professionally relevant perspectives (Ball & Bass, 2003). Such research seeks to parse the work of teaching into constituent parts for the purpose of understanding what is essential to doing it and to identifying its mathematical demands. It conceives of teaching as responsible design and management of the interactions among students and teacher around content as described by Cohen, Raudenbush and Ball (2003). Proposals for constituent tasks of teaching are systematically tested for consistency with data and with relevant theoretical and practitioner perspectives.

Research of this kind builds collections of robust ideas that can then be used, tested and refined. For instance, the activity of building measures for proposed concepts involves a process of operationalizing concepts in ways that can help to clarify ideas (Jacobson, Remillard, Thames & Aaron, in press). In addition, the measures themselves provide a critical tool for testing hypotheses about the constructs and their interactions. These three orientations are crucial to understanding the nature and role of mathematical tasks of teaching central to the development of a practice-based theory of MKT.

Mathematical tasks of teaching

Gallimore and Stigler (2003) propose that knowledge for teaching needs to be developed "in response to specific problems of practice" (p. 28). When Ball, Thames and Phelps (2008) presented a practice-based theory of content knowledge for teaching, they focused on the mathematical problems or challenges of teaching and the work necessitated by them. These researchers were surprised to see how much special mathematical knowledge was required, even in many everyday tasks of teaching such as assigning student work and listening to student talk. The identification of decidedly mathematical tasks, often situated in some broader, more general aspect of the work of teaching, led them to realize that these mathematical tasks of teaching could be used to highlight

important mathematical knowledge for teaching. A core idea in these attempts then, is to focus on the mathematical tasks that teachers have to deal with in the work they do that have significant mathematical entailments.

The research by Ball and her colleagues has produced numerous examples of mathematical demands faced by teachers and of mathematical knowledge and skill useful in teaching. These examples are situated in mathematically focused tasks of teaching, such as explaining why mathematical content makes sense, evaluating non-standard student work, choosing and using mathematical representations, and other tasks, as in figure 1.

The design of items (see e.g. figure 2) in this research has acquired a distinctive character of posing focused, mathematical questions situated in a pedagogical context where the pedagogical purpose is explicitly given. In these items, mathematical tasks of teaching serve as a kind of backbone inextricably linking mathematical knowledge to the work of teaching. As tasks of teaching, though, they need to be understood in the context of important developments in research on teaching.

Increasingly, scholars are arguing for the development of theories of teaching that stand as robust conceptions and models of the phenomenon rather than as specific approaches from which one chooses. Schoenfeld (2010) proposes a goal-oriented, decision-making theory of teaching using a behavioral-cognitive framing. Sztajn, Confrey, Wilson and Edgington (2012) propose the development of a theory of teaching organized around and grounded in research on student learning, in particular on learning trajectories. Grossman and McDonald (2008) argue for parsing teaching into an underlying grammar of practice grounded in conceptions of professional practice. All three of these proposals call for the development of a theory of teaching largely independent of culture, analogous to research on learning, which on the whole has developed theories of learning meaningful across culture. However, these three proposals offer different foundations for such a theory.

Consonant with the work of Grossman and her colleagues, research on MKT conceptualizes teaching as a grammar of professionally identifiable practice. Two ideas are important here: the professional basis for characterizing teaching (for instance in contrast to the psychological basis for characterizing learning) and the need for structurally parsing teaching. As Ball and Forzani (2009) argue in their analysis of the challenge of teacher education, the teaching of subject matter to students is an unnatural and intricate act that requires the development of decidedly professional competence. In making this argument, they define the "work of teaching" to be "the core tasks that teachers must execute to

help pupils learn" (p. 497). In describing what they refer to as "decomposition" of professional practice, Grossman and her colleagues (2009) refer to such tasks as "constituent parts" of teaching and argue that, strategically identified, they enable seeing and enacting elements of practice more effectively. This is the meaning of "tasks of teaching" that we argue represents a useful tool for measuring professional content knowledge internationally.

The decomposition of teaching into constituent tasks can be carried out at different levels and with different aims. As an example, consider the decomposition of the work of steering instruction toward a mathematical point provided by Sleep (2012). The aim of her study was to unpack the practices and knowledge demands of determining the mathematical goals of an activity and using those goals to design and steer instruction. Having analyzed the literature and her empirical data, she conceptualized "teaching to the mathematical point" as three interrelated types of work: "(1) articulating the mathematical point; (2) orienting the instructional activity; and (3) steering the instruction toward the mathematical point" (p. 247). She refers to the first two of these as "mathematical purposing" and acknowledges their cyclical relationship with steering instruction toward the mathematical point, but then focuses her analysis on decomposing this latter component of the work of teaching into seven constituent tasks:

> [A]ttending to and managing multiple purposes, spending instructional time on mathematical work, spending instructional time on the intended mathematics, making sure students are doing the mathematical work, developing and maintaining a mathematical storyline, opening up and emphasizing key mathematical ideas, and keeping a focus on meaning (Sleep, 2012, p. 935).

Having characterized constituent tasks of the work, she then identifies the MKT demands of different components of mathematical purposing.

The tasks of teaching identified by Sleep represent a decomposition of the work of steering instruction toward a mathematical point, with the broader goal of informing teacher education. She is not describing a particular approach to teaching, but proposing an important component of professionally responsible mathematics teaching. In research on mathematical knowledge for teaching, the first step is identification of some aspect of the work of teaching, but because the goal is the eventual identification of mathematical resources for teaching, the identification of tasks of teaching zoom in on particular mathematical tasks of teaching, often more specific and focused.

Common tasks of teaching across cultures

Although efforts to adapt measures to other countries need to take differences of cultural contexts into consideration to avoid confusion for test-takers, from the perspective of MKT the primary question is whether or not the work required to deal with a task of teaching – as presented in the problem posed in an item – is a legitimate demand for teaching. Kwon, Thames and Park (2012) found that while Korean teachers might find a certain context unfamiliar, they consistently felt that the mathematical question posed in the item was professionally realistic. The same opinion was evident in Norwegian interviews (Fauskanger & Mosvold, 2010).

The MKT item in figure 2 is about representations of fractions, and we use this item as a starting point for examining the role of tasks of teaching in measures of MKT.

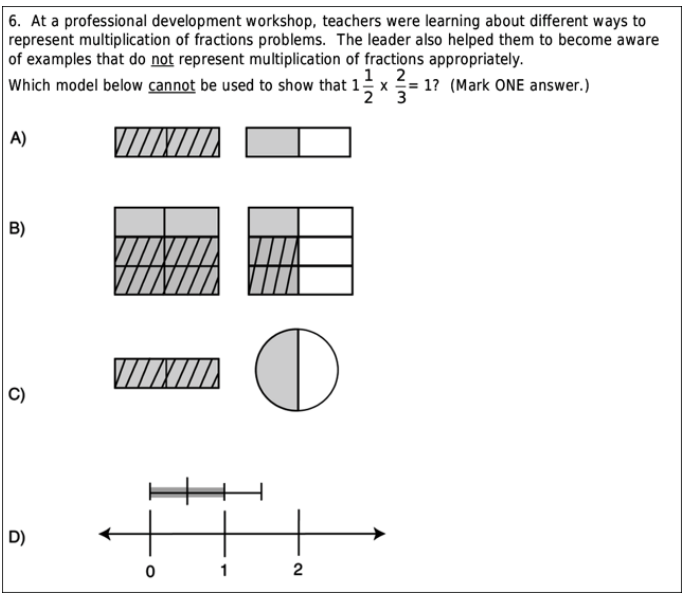

Figure 2. Example from LMT released items (Ball & Hill, 2008, p. 7).

This is an older released item, so one that has weaknesses, but it conveys the basic design and focus of MKT items. Whereas a typical mathematics test item might ask a test taker to identify a correct solution, this item requires thinking flexibly about different representations, but also maintaining mathematical integrity. The mathematical task of teaching implicit in this item is about choosing, using and evaluating

mathematical representations to model numerical computations. Option C) is the correct answer because it does not maintain a common unit for the 1 and the $\frac{1}{2}$ in the $1\frac{1}{2}$ (since this item was produced, it has become routine to make the task of teaching much more explicit).

When analyzing this item from a national-culture perspective, it might be argued that representations for fraction multiplication differ across cultures. Curricula differ, textbooks use different examples, and teachers organize their teaching in different ways across countries. A different cultural lens is that of a global-dynamic-cultural perspective, which assumes that a certain isomorphism exists or is growing across countries (LeTendre et al., 2001). From this view, perhaps the choice of a number line to represent fraction multiplication is minor and converging.

Although there are differences between national-culture perspectives and global-dynamic-cultural perspectives, LeTendre and colleagues (p. 5) argue that both "see schools, as well as the main tasks of instruction and the organization of teaching, as a chiefly cultural product." It is worth noting that when these authors talk about "tasks of instruction" and the "work of the teacher", they focus on organizational and structural aspects such as the number of lessons taught per week and whether or not teachers prepare lessons in groups, not on the work of managing instructional interactions as posited for MKT. This, we argue, is where the theory of MKT offers a significantly different starting point.

In a practice-based theory of MKT, tasks of teaching are conceived in reference to deliberation among professionals about effective instruction. Central to such deliberation is the identification of plausible conceptions of tasks of teaching around which professional consensus might be built. Tasks of teaching conceived in this way stand in contrast to ones identified in reference to particular approaches or particular cultural activities. The complication that arises is that no professional standards exist. Nevertheless, as Hiebert et al. (2002) argue, the teaching profession needs to grow a professional knowledge base and professional standards.

Given the current lack of professional standards, a natural question is how decisions about foundational tasks of teaching mathematics might be made. From our reading of the literature and from our experiences with focus-group discussions of items, cognitive interviews with people doing items, public vetting of items in professional settings and efforts to adapt measures internationally, we have found that many of the tasks of teaching used in validated MKT measures stand up well to widespread professional scrutiny (e.g. Fauskanger et al., 2012; Kwon et al., 2012). Furthermore, when they do not, professional deliberation often leads to clarification of tasks of teaching and improvement of items. In this picture of professional knowledge, it is important to note that existing conceptions

and measures are only a first step in growing a knowledge base for the teaching profession. Existing MKT measures need to be viewed as a work-in-progress. This view applies equally to the use of the measures in the United States and to their use internationally. In both cases, they should be viewed as built from current best plausible conceptions of professionally defensible tasks of teaching and associated mathematical demands. In both cases, item-specific deliberation can inform their improvement – and variability within and among cultures can provide insights.

Indeed, efforts to identify and measure professional knowledge could inform the building of professional standards. In other words, mathematical tasks of teaching, understood as underlying the common endeavor of teaching mathematics to students across individual students, across school contexts and across cultures, can serve as a foundational layer in conceptions and measures of mathematical knowledge for teaching, with such differences acting as a second layer in the construction and adaptation of conceptual frameworks and measures. The use of such tasks in analyses of teaching and in measures of teacher content knowledge may require secondary adjustments to accommodate factors such as language and major curricular differences, but these adjustments would not undermine integrity of the basic mathematical tasks.

When adapting an item like the one above (see figure 2), judgments need to be made with regard to what is at issue. Our argument highlights the need to consider the nature of professional knowledge as well as differences in cultural contexts. The particular context in the item probably has little impact on what the item measures, especially in the context of knowledge for teaching mathematics where the ability to see implications for the choice of a representation is central to what is being measured.

Conclusion

Cross-national studies of teaching mathematics have identified differences in schooling and teaching practice within as well as across cultures. When examining MKT across cultures in light of this, a natural conclusion seems to be that there must also be cultural differences in the tasks of teaching mathematics. We offer a different argument: 1) teaching as currently practiced lacks shared technical knowledge and language that would distinguish it as a profession (cf. Lortie, 1975); 2) given the current lack of professional knowledge and language, candidate characterizations of mathematical tasks of teaching are needed; 3) plausible candidates would need to hold up to deliberation among professionals engaged in varied approaches to teaching within and among different contexts,

including different cultures; 4) such mathematical tasks of teaching would provide a foundation for sharing a practice-based theory of MKT and measures of MKT across different cultures, with adaptation mostly focused on translation-like issues. To accomplish this, it is essential that the focus is on *mathematical* challenges related to a bootstrapped conception of professional knowledge and work. Conceived thus, mathematical tasks of teaching are relatively independent from cultural differences in organizational and structural aspects of teaching and even from many idiosyncrasies in cultural approaches to teaching.

References

Ball, D. L. & Bass, H. (2000). Making believe: the collective construction of public mathematical knowledge in the elementary classroom. In D. Phillips (Ed.), *Constructivism in education* (Yearbook of the National Society for the Study of Education) (pp. 193–224). University of Chicago Press.

Ball, D. L. & Bass, H. (2003). Toward a practice-based theory of mathematical knowledge for teaching. In B. Davis & E. Simmt (Eds.), *Proceedings of the 2002 Annual Meeting of the Canadian Mathematics Education Study Group* (pp. 3–14). Edmonton: CMESG/GCEDM.

Ball, D. L. & Hill, H. C. (2008). *Mathematical knowledge for teaching (MKT) measures. Mathematics released items 2008*. Retrieved from http://sitemaker.umich.edu/lmt/files/LMT_sample_items.pdf

Ball, D. L., Thames, M. H. & Phelps, G. (2008). Content knowledge for teaching: What makes it special? *Journal of Teacher Education*, 59 (5), 389–407.

Ball, D. L. & Wilson, S. M. (1996). Integrity in teaching: recognizing the fusion of the moral and intellectual. *American Educational Research Journal*, 33 (1), 155–192.

Blömeke, S. & Delaney, S. (2012). Assessment of teacher knowledge across countries: a review of the state of research. *ZDM*, 44 (3), 223–247.

Cohen, D., Raudenbush, S. & Ball, D. L. (2003). Resources, instruction, and research. *Educational Evaluation and Policy Analysis*, 25 (2), 1–24.

Cole, Y. (2012). Assessing elemental validity: the transfer and use of mathematical knowledge for teaching measures in Ghana. *ZDM*, 44 (3), 415–426.

Delaney, S. (2008). *Adapting and using U.S. measures to study Irish teachers' mathematical knowledge for teaching* (Unpublished doctoral dissertation). Ann Arbor: University of Michigan.

Delaney, S., Ball, D. L., Hill, H., Schilling, S. & Zopf, D. (2008). "Mathematical knowledge for teaching": adapting U.S. measures for use in Ireland. *Journal of Mathematics Teacher Education*, 11 (3), 171–197.

Fauskanger, J., Jakobsen, A., Mosvold, R. & Bjuland, R. (2012). Analysis of psychometric properties as part of an iterative adaptation process of MKT items for use in other countries. *ZDM*, 44 (3), 387–399.

Fauskanger, J. & Mosvold, R. (2010). Undervisningskunnskap i matematikk: tilpasning av en amerikansk undersøkelse til norsk, og læreres opplevelse av undersøkelsen [Mathematical knowledge for teaching: Adaptation of an American measure into Norwegian and teachers' experience with the measure]. *Norsk Pedagogisk Tidsskrift*, 94 (2), 112–123.

Gallimore, R. & Stigler, J. (2003). Closing the teaching gap: assisting teachers to adapt to change. In C. Richardson (Ed.), *Whither assessment* (pp. 25–36). London: Qualifications and Curriculum Authority.

Grossman, P., Compton, C., Igra, C., Ronfeldt, M., Shanan, E. & Williamson, P. W. (2009). Teaching practice: a cross-professional perspective. *Teachers College Record*, 111 (9), 2055–2100.

Grossman, P. & McDonald, M. (2008). Back to the future: directions for research in teaching and teacher education. *American Educational Research Journal*, 45 (1), 184–205.

Hiebert, J., Gallimore, R. & Stigler, J. W. (2002). A knowledge base for the teaching profession: What would it look like and how can we get one? *Educational Researcher*, 31 (5), 3–15.

Hiebert, J. et al. (2003). *Teaching mathematics in seven countries – results from the TIMSS 1999 video study*. Washington: National Center for Education Statistics (NCES), US Department of Education.

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

Jacobson, E., Remillard, J., Thames, M. H., Aaron, W. (in press). The productive interplay between measure design and construct development. In A. Izsák & J. Remillard (Eds.), *Psychometrics and assessment in mathematics education: opportunities, challenges, and interdisciplinary collaborations. Journal for Research in Mathematics Education, Monograph*.

Kwon, M., Thames, M. H. & Pang, J. S. (2012). To change or not to change: adapting mathematical knowledge for teaching (MKT) measures for use in Korea. *ZDM*, 44 (3), 371–385.

LeTendre, G. K., Baker, D. P., Akiba, M., Goesling, B. & Wiseman, A. (2001). Teachers' work: institutional isomorphism and cultural variation in the U.S., Germany, and Japan. *Educational Researcher*, 30 (6), 3–15.

Lortie, D. C. (1975). *Schoolteacher: a sociological study*. University of Chicago Press.

Ng, D. (2012). Using the MKT measures to reveal Indonesian teachers' mathematical knowledge: challenges and potentials. *ZDM*, 44 (3), 401–413.

Schilling, S. G. & Hill, H. C. (2007). Assessing measures of mathematical knowledge for teaching: a validity argument approach. *Measurement*, 5 (2-3), 70–80.

Schoenfeld, A. H. (2010). *How we think: a theory of goal-oriented decision making and its educational applications*. New York: Routledge.

Shulman, L. S. (1986). Those who understand: knowledge growth in teaching. *Educational Researcher,* 15 (2), 4–14.

Sleep, L. (2012). The work of steering instruction toward the mathematical point: a decomposition of teaching practice. *American Educational Research Journal*, 49 (5), 935–970.

Stevenson, H. W. & Stigler, J. W. (1992). *The learning gap – why our schools are failing and what we can learn from Japanese and Chinese education*. New York: Touchstone.

Stigler, J. W. & Hiebert, J. (1999). *The teaching gap: best ideas from the world's teachers for improving education in the classroom*. New York: Free Press.

Sztajn, P., Confrey, J., Wilson, P. H. & Edgington, C. (2012). Learning trajectory based instruction: toward a theory of teaching. *Educational Researcher,* 41 (5), 147–156.

Xu, L. & Clarke, D. (2013). Meta-rules of discursive practice in mathematics classrooms from Seoul, Shanghai and Tokyo. *ZDM*, 45 (1), 61–72.

Mark Hoover

Mark Hoover is Assistant Research Scientist in Educational Studies at the University of Michigan, Ann Arbor, MI. His research investigates the practice of teaching mathematics, including research on equitable teaching, measures of teacher knowledge and designs for collective work on teaching.

mthames@umich.edu

Reidar Mosvold

Reidar Mosvold is Associate Professor in mathematics education at the University of Stavanger, Norway. His research interests are related to mathematical knowledge for teaching, teacher beliefs and use of history of mathematics in mathematics education.

reidar.mosvold@uis.no

Janne Fauskanger

Janne Fauskanger is Assistant Professor in mathematics education at the University of Stavanger, Norway. Her main research interests are related to teachers' beliefs and mathematical knowledge for teaching and their influence on teaching practice.

janne.fauskanger@uis.no