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Editorial

Evidence-based Approaches to Developing Content Knowledge and Pedagogical Content Knowledge in Pre-service Mathematics Teacher Education

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Shulman's (1987) seminal work addressing teachers' knowledge triggered a deluge of studies aiming to identify, describe, and measure components of the nine knowledge types that he identified. A variety of approaches has been used to investigate these knowledge constructs, including classroom observations, questionnaires, and interviews (e.g., Chick, 2007); profiling instruments (e.g., Watson, 2001); and multiple-choice tests (e.g., Hill, Schilling, & Ball, 2004). Each approach has increased understanding of the work of teaching—especially PCK—but has also highlighted the challenges of examining teacher knowledge. More recently, attention has turned to pre-service teachers (PSTs), with the international Teacher Education and Development Study in Mathematics (TEDS-M) (Tatto, Schwille, Senk, Ingvarson, Peck, & Rowley, 2008) using instruments that identified PSTs' mathematics content knowledge and pedagogical content knowledge (PCK). In Australia, Callingham et al. (2011) developed measures of PSTs' knowledge in three domains: beliefs, content knowledge, and pedagogical content knowledge.

Alongside this research activity, professional bodies also started to define expectations for teachers' knowledge. The Australian Association of Mathematics Teachers (AAMT) (2006), for example, provided Standards of Excellence in Teaching Mathematics based on discussion with teachers of mathematics at all levels of teaching. These standards incorporated many of Shulman's knowledge types. Australian education systems and governments have also shown increasing desire to improve the quality of teachers exiting from teacher education courses. In 2011, generic teaching standards were developed for all teachers (Australian Institute for Teaching and School Leadership (AITSL), 2011), to set expectations of teachers at different career levels, including upon graduation.

With the recent attention on teacher preparation, it seemed timely to examine the ways in which research is informing the work of teacher education programs, through a focus on mathematics content and PCK. The collection of papers in this special issue indicates that there are many ways of examining

PSTs' knowledge that provide evidence for different purposes. They highlight the ways in which knowledge might be shaped and prioritised, how teachers may be susceptible to misconceptions in acquiring such knowledge, how it might be developed during practise, and to what extent it can be measured. Several papers focus on the content knowledge of PSTs. Linsell and Anakin used two different tools to explore "foundation content knowledge", to examine the broad mathematical readiness of teachers entering teacher education programs aiming to address their learning needs. More specifically, Young-Loveridge, Bicknell, and Mills focus on the number strand of the mathematics curriculum, and consider the success of PSTs on number tasks in relation to their attitudes towards mathematics. Meaney and Lange discuss the nature of mathematical knowledge for teaching that PSTs need to acquire as part of developing their identities as teachers, and argue that, despite some benefits, overall skills tests caused PSTs to take a narrow view of mathematical knowledge. Beswick and Goos look more broadly at a number of aspects of knowledge, and report on a set of measures of PSTs' beliefs, content knowledge, and PCK. They raise issues associated with the measurement of PSTs' mathematical knowledge. Livy, Muir, and Maher consider specific knowledge of area and perimeter, finding that many PSTs demonstrate common misconceptions seen in school children. In contrast, Aguirre, Zavala, and Katanyoutanant stress the importance of cultural knowledge, extending the notion of PCK to include cultural responsiveness so as to teach a wide range of children more effectively. The practical knowledge that teachers need is the subject of the paper by Viseu and da Ponte. Using a case study, they demonstrate the use of technology during practicum placement to support a PST to develop a broader range of pedagogical skills.

It is clear from these papers that teacher education has a responsibility to ensure that PSTs have opportunities to develop broad understanding of mathematical knowledge in a range of contexts. The very diversity of the papers, however, highlights the vast repertoire of knowledge that might be desirable for teachers, and the results present a number of challenges for researchers and teacher educators. For educators, calls to lift qualifications or performance of entering students may increase the levels of content knowledge of PSTs, but the development of PCK—and its relationship to content knowledge—is still uncertain. For researchers, the task of gathering appropriate and measurable evidence of PCK and its growth, in particular, is still an unresolved work in progress.

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