Editorial

Implementing innovations in teacher education

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We are pleased to present the first issue of MTED for 2017. This issue presents work from both Australasia and an international context and involves the learning of pre-service teachers, in-service teachers and teacher educators. A common theme across all the articles is a focus on innovations in mathematics teacher education in order to improve practice. There is recognition in each article that mathematics teacher education programmes whether with pre-service teachers or in-service teachers play an important role to potentially shape and lead reform in mathematics education across different sectors. The first two articles in this issue focus on in-service teacher education and both incorporate the use of demonstration lessons in order to facilitate experienced teachers to reflect upon innovative pedagogy and practices. The following five articles focus on aspects of pre-service teacher education. All seven studies draw on different methodologies but are qualitative studies that provide a rich account of participants' observations and reflections.

The paper by Loong, Vale, Herbert, Bragg, and Widjaja, *Tracking change in primary teachers' understanding of mathematical reasoning through demonstration lessons,* investigates the impact of a professional learning programme on teachers' perceptions of mathematical reasoning. These researchers argue that teachers need to have a strong understanding of what mathematical reasoning entails in order to support students to productively reason during mathematics lessons. To achieve this, the professional learning programme involved observations of demonstration lessons, pre and post lesson discussions and an expectation that each teacher would also teach the lesson in their own classroom. A series of interviews were undertaken with the teacher participants and a perception of mathematical reasoning framework (Herbert et al., 2015) was used to track changes in the teachers' understanding of mathematical reasoning. The findings demonstrated a range of factors that enabled teachers to develop their understanding of mathematical reasoning. This included an intentional focus on key aspects of reasoning during demonstration lessons to provide opportunities for teachers to reflect upon new pedagogical approaches and observe students; collaborative reflective discussions involving deliberation of student responses, collegial discussion and reflection on ideas; and teacher enactment of the demonstrated lesson. The researchers also contend that poor content knowledge may negatively influence shifts in teacher understanding of mathematical reasoning.

The use of demonstration lessons with in-service teachers was also used in the paper, *How does lesson structure shape teacher perceptions of challenging tasks,* by Russo and Hopkins. Drawing on a range of research studies (e.g., Cheeseman, Clarke, Roche & Wilson, 2013; Darragh, 2013)

the authors highlight that despite reforms and a focus on the use of challenging tasks in mathematics classrooms, many teachers remain reluctant to include challenging tasks in their mathematics instruction. The key focus of this study was on how lesson structure shapes teachers' perceptions of teaching with challenging tasks. To achieve this, demonstration lessons were used to explore teacher perceptions of the two differently structured lessons. These lessons were both taught by the researcher and incorporated two different approaches; task first approach, where the challenging task was used to launch the lesson; or teach first approach, where the challenging task was used to further extend student thinking. Semi-structured interviews helped to explore the teachers' perceptions following the demonstration lessons. A key finding of the study was that both approaches were viewed by the teacher participants as having specific strengths. Using a task first approach was identified as an engaging and empowering approach with heightened opportunities for creativity, persistence, mathematical discussion, and opportunities for assessment. In contrast, the teach first approach was perceived as a highly focused approach and one which offered greater opportunities to lower achieving or less confident students. The authors also note that for this group of teachers it appeared that using challenging tasks with an appropriately aligned pedagogy was perceived as equally important as the lesson structure.

Shifting the view to pre-service teacher (PST) education, the paper by Cavanagh and McMaster, *A specialist professional learning community for primary pre-service teachers focused on mathematical problem-solving,* focuses on the teaching of mathematics as problem-solving. It begins with an overview of the difficulties that PSTs may encounter related to teaching mathematics through problem-solving due to their previous experience and mathematical content knowledge. In this study, the PSTs formed a learning community for teaching mathematical problem-solving lessons to a composite Year 5/6 class. The researchers evaluated aspects of the professional experience learning community with reflective journals, questionnaires, and semi-structured interviews. This study confirmed earlier work by Bailey and Taylor (2015) but argues that PSTs need to go beyond having experiences as learners in problem-solving situations to experience the teacher lens as well. The findings illustrate the benefits of co-planning and co-teaching and show how the use of a learning community and specific focus can result in PSTS thinking more deeply about problem solving lessons through the lens of a teacher and also developing knowledge, skills and confidence in teaching this type of lesson. The researchers argue that experiences such as these raise the likelihood of PSTs testing and developing their skills in teaching these lessons in future placements.

With a different focus on pre-service teacher education, the paper *Reading and reflecting: Elementary pre-service teachers' conceptions about teaching mathematics for equity,* by Jackson and Jong draws on a study of a cohort of PSTs to examine how reading and reflection about equity can be used as a tool to develop understanding in this area. Equity is positioned as an important issue by these researchers as they argue that despite the growing body of research (e.g., Gates & Jorgensen, 2009; Leonard & Evans, 2012) on equity, often PSTs and in-service teachers find it difficult to adopt a non-neutral view of mathematics. The key focus of this study was on how two readings could elicit PSTs conceptions of equity and the role of written reflections in a math methods course. The data used in this study was drawn from written reflections and a whole class discussion. The researchers illustrate how written reflections can be used as a spring-board to discuss equity issues. Analysis of the data highlighted three key themes in the responses of the PSTs. Firstly, the need to make mathematics relevant for students; secondly a perceived need to focus more on "mathematics" and not on students' culture; and finally the influence of the readings and reflections to broaden perspectives on mathematics education. Interestingly,

after reading and reflecting on equity issues, many of the PSTs reported that they now wanted to research other cultures to better develop their understanding.

Zambak and Tyminski in the paper titled, *A case study on specialised content knowledge development with dynamic geometry software: The analysis of influential factors and technology beliefs of three pre-service middle grades mathematics teachers,* focus our attention on the development of specialised content knowledge with dynamic geometry software. The authors propose electronic technology as a means to develop content knowledge. This study involved PSTs and looked at factors that influenced their development of specialised content knowledge (SCK). With semi-structured clinical interviews, including PSTs responses to tasks and questions to measure beliefs about technology, the researchers were able to observe how dynamic geometry software (DGS) influenced SCK. The results showed that enabling factors for developing SCK with DGS included opportunities to justify ideas, level of common content knowledge, and beliefs about technology. Similar to Cavanagh and McMaster earlier in this issue, the researchers highlight the need to design programmes that support PSTs to develop own mathematical content knowledge. This paper adds to the literature which challenges mathematics teacher educators to consider how to meet the need of PSTs when they have insufficient mathematics content knowledge.

The final two papers in this issue focus on elements of assessment in relation to work with PSTs. The paper by Smith, Tinkler, DeMink-Carthew, and Tinkler, *Pre-service mathematics teachers' experiences with proficiency based learning* focuses on the impact of PSTs experiencing proficiency based learning system during a methods course. Proficiency based systems allow students multiple opportunities to demonstrate proficiency based on an assessment linked to learning outcomes. This necessitates shifts in both instructional practice and assessment based practices and requires changes to teacher education programmes. This study used a case study methodology and drew on reflections, interviews and course materials to investigate how PSTs develop their professional skills and practices with proficiency based learning system. The findings describe the key affordances highlighted by the PSTs as flexibility (in relation to pace along with the way they learnt and were assessed), multiple opportunities to demonstrate learning, awareness of progress and process and awareness of gains in pedagogical content knowledge. Challenges were also noted by the PSTs which were centred on the potentially high workload of proficiency based learning systems and the need to develop rich understanding of the nuances of different levels of proficiency.

Assessment is also a key focus in the paper, *Action research in the application of variation theory in mathematics teacher education,* by Bragg. This author blended action research and variation theory to examine how action research could improve the educational design of an assessment for learning task as well as PSTs understanding of the task. The assessment task itself involved problem pictures, where PSTs take a photograph and then develop 3 open ended maths questions from this. Initial findings showed that PSTs often have difficulty choosing photos of the environment which are interactively mathematical and frequently select illustrative photos. Drawing on elements of variation theory, the researcher used contrasting photos to show what mathematics is residing and what is interactively mathematical or illustrative. Variations were used to improve the assessment task for student understanding. Other foci which supported students' growing understanding of the task were an emphasis on pictures and questions which were inclusive, and aspects of professional seeing highlighted through peer tutoring and collaborative work and trialling the task with children.

Action research with PSTs to increase understanding of assessment task and its value. Each cycle had variation in assessment tasks instructions – drew on variation theory. Blends two theories action research and variation theory. Key focus – how can action research improve the

educational design of an assessment for learning task as well as students understanding of the task. Assessment task involves problem pictures where students take a photo and then develop 3 open ended maths questions from this. Initially students have difficult choosing photos of the environment which are interactively mathematical – often choose illustrative photos. Researcher used contrasting photos to show what mathematics is residing and what is interactively mathematical or illustrative. A further focus is on pictures and questions which are inclusive – finally aspect of professional seeing – peer tutoring and trial task with children. Variations to improve assessment task for student understanding.

The articles collected in this issue contribute in supporting us to reflect on how interventions with both in-service and pre-service teachers may lead to teachers improving practice in mathematics education. Collectively, these papers highlight different ways in which teachers can be facilitated to engage in innovative teaching approaches while also suggesting areas for ongoing development. Findings such as these are helpful to inform our collective practice as researchers and mathematics teacher educators.

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