Symposium: Effective Mathematics Teaching: Building Partnerships to Co-Develop Evidence-Based Capability

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Providing professional development at scale requires engaging diverse stakeholders to ensure support is based on research evidence and meets a range of teachers' needs. This symposium outlines research, partnerships and initiatives undertaken by a mathematics team in a state department of education to build a cohesive network of resources and professional learning to improve mathematics teaching and learning across the state.

Supporting teachers with relevant resources and professional learning is a priority to promote improvement in mathematics teaching and learning. At a systemic level, providing support at scale while recognising the highly diverse needs of teachers and schools is a well-documented challenge. A significantly revised mathematics curriculum has heightened the need for timeliness and range of expertise and perspectives. Collectively, the papers in this symposium tell a story of how a state department of education strategically partnered with mathematics education researchers, teachers and schools to design and implement a range of co-ordinated initiatives to support teachers and improve students' learning in mathematics.

In the first paper, Wood and her colleagues outline the history and background of ways that the Queensland Department of Education (the Department) have sought to support teachers to develop their mathematics pedagogy through a range of strategic partnerships across two decades. In *Building system-wide mathematics pedagogy through collaborative partnerships*, the authors discuss the impetus behind building teachers' pedagogical expertise in guided mathematical inquiry by working with mathematics education researchers as critical friends and developing resources at scale. In the second paper, *Designing curriculum resources to support teacher learning,* Goos details her theoretical analysis of the design of resources supporting teachers to "learn how to learn" to teach content that was new to them in the Queensland senior secondary mathematics syllabuses. Her paper exemplifies the Department's initiative to create a suite of professional learning materials for teachers designed by mathematics education researchers in a range of topics in mathematics curriculum, pedagogy, and classroom strategies. In the next paper, *Building capability: What to do when you don't know what to do,* school practitioners Moran and Lambie discuss how their school worked with a mathematics education researcher as a critical friend to address a problem of practice: improving students' performance on a new state assessment using complex, open-ended problems. They provide school-based evidence of how the using a research-based framework supported students to build confidence in addressing these tasks. Finally, in *Building capability for teachers of mathematics,* Horne and Hillman outline the partnership between the Department and an experienced teacher to develop resources that build teachers' capabilities in teaching mathematics. The 'How to Teach Mathematics Toolkit' seeks in particular to support beginning teachers and those teaching mathematics out-of-field in an online resource.

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Building Capability for Teachers of Mathematics

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Teaching resources and professional development based on mathematics education research have the potential to support teachers to develop and sustain improved pedagogies. The Queensland Department of Education provided online professional learning modules for teachers of Prep (Foundation) to Year 10 mathematics . To support implementation of the Australian Curriculum: Mathematics this evidence-based resource would assist teachers in understanding the curriculum and providing support for quality teaching and learning. This resource exemplifies the partnerships between the department, researchers and teachers in building capability in mathematics teaching.

The notion of curriculum is not static, with distinctions made between what is intended by curriculum writers and how curriculum is enacted in the classroom (Remillard & Heck, 2014). Teacher resources can greatly influence how teachers interpret the curriculum, and innovative resource materials have long been used to support teachers adopt more effective pedagogies (Ball & Cohen, 1996; Pepin, 2018). "The characteristics of these innovative materials ultimately influence teachers' instructional practices, including their use of curriculum materials" (Choppin, 2011, p. 332). Because of their potential impact on teachers' pedagogy, it is essential for resource materials draw on evidence of effective practice and based on contemporary research (Irgens et al., 2023; Munter, 2014; Roesken-Winter et al., 2021; Sullivan, 2011).

In this paper, we outline how a state education department developed an evidence-based online teacher capability to support beginning, returning and out of field teachers in diverse school and community contexts to implement Australian Curriculum: Mathematics by partnering with university researchers and teachers as co-constructors.

Promoting System-Wide Capability Development in Mathematics Pedagogy

The Queensland Department of Education (the Department) outlines its commitment to realizing the potential of every student, including the prioritising achievement in mathematics, in the education strategy, Equity and Excellence. Version 9.0 of the Australian Curriculum highlighted the need for state-wide capability-building for teachers of mathematics. The challenge was also identified in providing systematic and contextualised capability development in mathematics pedagogy for a range of teacher needs that draws on contemporary research. These challenges have been identified in research beyond Australia as well:

> Mathematics teachers face challenges in modifying their teaching to incorporate effective pedagogical practices, technology tools, and new curricula resources. They also face challenges in making changes to address updated standards and expectations for mathematics. … Teachers often have limited resources to support professional development to learn how to make these changes. Many teachers are seeking out online professional development opportunities. … Evidence suggests online professional development (PD) that is accessible, meaningful, collaborative, and addresses varied needs and abilities of participants can lead to changes in teachers' instructional practices. (Hollebrands & Lee, 2020, pp. 859–860)

A universal, online resource would provide foundational instruction tailored to beginning, returning, and out of field teachers of mathematics, and accessible to all state school teachers in Queensland. This was realised through the redevelopment of the 'How to Teach Mathematics Toolkit' (the toolkit). To maximise relevance and engagement for teachers, the resource offers online, self-directed modules with research-validated information and advice to build teacher knowledge, skills, and understanding of mathematics curriculum and pedagogy embedded in

the context of teachers' classrooms and supported with peers (Kleiman et al., 2015; Powell & Bodur, 2019). Teachers' engagement in substantial professional learning resources such as this has been shown across multiple studies to have substantial improvement in student learning (Yoon et al., 2007).

The Department has a long history of creating and sustaining partnerships with researchers on the improvement journey of mathematics curriculum and pedagogy (Horne & Makar, 2013). Existing and new research partnerships were activated to ensure the resource was informed by leading edge evidence of effective pedagogy in mathematics (cf. Berger & Baker, 2008; Lillejord & Børte, 2016). Collaborative research partnerships were instrumental to this resource in three ways: knowledge translation, critical friends, and content co-developers (Irgens et al., 2023). Collaborative teacher partnerships were equally important providing lesson plans and videos demonstrating examples of content, mathematical guided inquires and related assessment.

Designing a Capability Resource Using Evidence-Based Practices

The toolkit is focused on evidence-based research and is organised over eight modules. The modules address current teaching and learning, the structure of the Australian Curriculum: Mathematics—including the mathematical proficiencies (Understanding, Fluency, Problem solving, Reasoning), and the importance of ongoing teacher personalised learning (Figure 1).

Figure 1

How to Teach Mathematics Toolkit Professional Development Modules

Research on teacher professional learning has highlighted that teachers value professional development that includes a focus on content, active learning, alignment with curriculum, and engagement over time (Haug & Mork, 2021). In the Teaching and Learning modules (1–3), teachers will explore:

- *Teaching Mathematics*: Mathematical opportunities, knowing and planning the curriculum and mathematical content, knowing how to plan a lesson;
- *Mathematics in the classroom*: Addressing you own self-efficacy, understanding your school's context, knowing your students with a focus on assessment and differentiation and how to support mathematical language within the classroom;

- *Teaching practices*: Understanding effective teaching of mathematics, focusing on positive dispositions, orchestrating classroom discourse, supporting student engagement and pedagogy in the mathematics classroom.

Modules 4–7 model the structure of the Australian Curriculum: Mathematics. By unpacking the mathematical proficiencies (*Understanding, Fluency, Problem solving, Reasoning*). Within each proficiency, the modules use content strands in teaching, learning, and assessing the proficiency with lessons and assessment ideas for each phase of schooling (Prep to Year 2, Year 3 to 6 and Years 7 to 10).

Finally, *Personalised learning* supports teachers in their understanding of continued learning in teaching and learning mathematics and reflect on their own self-efficacy.

The toolkit modules are self-paced and combine online learning and offline self-reflection and practical application. Importantly, there are opportunities for participants to consolidate and extend their learning through collaborative activities with a mentor, thus allowing a contextualised approach (Fantilli & McDougall, 2009). The toolkit encourages further reading and engagement with research through the resources lists included at the end of each module.

The toolkit modules are designed to align to the Australian Institute for Professional Standards (AITSL) so that completion of the course contributes to teachers' continuing professional development requirement for registration. This validates participants' investment of time in completing the toolkit. Teachers have the opportunity to collect evidence of their participation by recording reflections, mentoring discussions, implementation trials in the classroom, peer observations and student observations and work samples.

Next Steps—Supporting Mentoring and Scaling up Effective Practice

In the context of widespread teacher shortages the Department recognises the critical importance of universal access to high quality professional learning in mathematics, scaling up effective practice, sharing expertise through clusters and attending to teacher wellbeing (Haug & Mork, 2021; Irgens et al., 2023; Powell & Bodur, 2019). There are opportunities to support mentoring partnerships through:

- Mobilising suitable expertise as mentors within/across the department and in research organisations;
- Facilitate clusters to share expertise—strengthen and expand the network of mathematics educators by supporting partnerships between teachers and researchers as mentors.

There are opportunities to embed toolkit modules in initial teacher education programs to support transition of beginning teachers into mathematics classrooms in Queensland state schools.

Conclusion

The *How to Teach Mathematics Toolkit* is an evidence-based resource to promote system-wide capability development in mathematics pedagogy in Queensland state schools. It supports the implementation of Australian Curriculum: Mathematics in F–10, and combines both universal access and contextualised implementation to maximise reach and impact. It builds and shares expertise in mathematics pedagogy through collaborative partnerships to build capability of teachers to deliver quality teaching and learning in mathematics.

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