

Mathematical Sequences of Connected, Cumulative and Challenging Tasks in the Early Years

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This symposium reports on a project that focused on *Exploring the Use of Mathematical Sequences of Connected, Cumulative and Challenging Tasks (EMC³)* with students in the early years (Foundation Level to Year 2). The project was funded by the Australian Research Council, Catholic Education Diocese of Parramatta and Melbourne Archdiocese Catholic Schools (LP180100600). Together with industry partners the EMC³ project was designed to enhance the cognitive and affective experiences of students when learning mathematics by researching teaching approaches that utilise sequences of cognitively challenging tasks.

Paper 1: *Exploring the Potential of Sequences of Connected, Cumulative and Challenging Tasks in the Early Years* [Peter Sullivan, Melody McCormick]

This paper outlines the rationale for the teaching approach the EMC³ project aimed at studying an approach to teaching and learning mathematics in the early years (students aged 5–9).

Paper 2: *Differentiating Mathematics Instruction through Sequences of Challenging Tasks in the Early Primary Years* [James Russo, Jane Hubbard]

This paper reports on post-program questionnaire data collected from 100 teachers who express their views about the effectiveness of various instructional approaches to support differentiation in mathematics.

Paper 3: *Changing Teacher Practices: A “Slow Burn” or Rapid with “Big Shifts.”*
[Sharyn Livy, Janette Bobis, Ellen Corovic, Maggie Feng]

This paper reports on interview data collected from five teacher educators who provided support to the teachers when trialing the EMC³ resources. The focus of this presentation will be on the notable changes to teacher practices.

Paper 4: *The Nature of Leadership and Other Support that Facilitate Innovation and Improvement in Teacher Practice.* [Ann Downton, Janette Bobis]

The final paper reports on survey data collected from 70 teachers about the forms of support that assisted implementation of project resources—in-class support and facilitation of planning.

Changing Teacher Practices: A “Slow Burn” or Rapid with “Big Shifts”

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This paper focuses on the time teachers take to adapt to a student-centred inquiry approach to teaching mathematics, the nature of those changes and the reasons for variations in both these aspects among teachers within and across schools. Five numeracy experts, who worked with 200 Foundation to Year 2 teachers to facilitate the implementation of the approach, were individually interviewed at the end of the year to obtain their perspectives on teachers’ adaptation. Thematic analysis of the data revealed two overarching themes—context and teacher agency. The findings reinforce recommendations that professional learning providers acknowledge and take account of individual teacher learning trajectories to maximise potential change in practices.

Most experts in the field of teacher professional learning consider achieving significant change to teachers’ practices to be a difficult and slow process (e.g., Guskey, 2003). However, there are examples constantly emerging of teachers who have made profound changes to their beliefs and practices in relatively short periods of time (e.g., Bobis et al., 2016). Those studying the reasons for the differential impact of professional learning interventions on teachers have taken different perspectives. For instance, Huberman (1993) and Brunetti and Marston (2018) identified numerous phases or career stages that teachers characteristically experience as part of their professional development journeys. Huberman also developed several models representing the potential reasons for variations in teacher developmental trajectories. Similarly, Gregoire (2003) proposed a model of teacher conceptual change accounting for affective and cognitive teacher characteristics that could potentially determine variations in teacher readiness to change their beliefs and practices. Together, these studies reveal commonalities of teacher learning and suggest potential reasons for variations in the time individual teachers take and the degree to which change occurs. In particular, the findings highlight the importance of context (physical and social environment) and teacher agency (their sense of empowerment and willingness to act) to help facilitate change. Brunetti and Marston (2018) explain that the influence of context on teacher development needs to be studied in terms of both *space* (e.g., school resources and leadership) and *time* (e.g., teacher prior learning). Importantly, a connection between context and teacher agency exists. In exploring this connection, Beauchamp and Thomas (2009) suggested that a strong sense of teacher agency has the power to “transform the context” (p. 183). This means that even in the face of contextual constraints, teachers with a strong sense of agency can still experience rapid and big shifts in their approaches to teaching.

The focus of this paper is on the time teachers take to adapt to a student-centred inquiry approach to teaching mathematics, the nature of those changes and the reasons for variations in both these aspects across schools and among teachers within schools. An understanding of such development is important to school and system leaders, and designers of professional learning (PL) to ensure they appropriately respond to the professional needs of teachers.

Background to the Study and Setting

This study was conducted as part of a large, funded research project, *Exploring Mathematical Sequences of Connected, Cumulative and Challenging Tasks (EMC³)*. This project involved working with approximately 200 Foundation to Year 2 (F-2) teachers from 19 different schools across two Australian states of New South Wales and Victoria each year for three years in a PL intervention. Following PL days conducted at the start of each school year, teachers implemented multiple sequences of challenging tasks utilising a student-centred inquiry approach that is described in detail by Sullivan et al. (2020) and outlined in Sullivan and McCormick (Paper 1) as part of this symposium. To support implementation of the approach, one school system participating in the project, engaged five system-level numeracy content-specific experts referred to as Teaching Educators (TEs), to assist individual schools and teachers. The nature of their support is detailed in Downton et al. (Paper 4) as part of this symposium, but in brief, TEs assisted individuals and teams of teachers to plan and teach the sequences. They also regularly observed lessons and facilitated post-lesson debriefing sessions where teacher practices and student responses were unpacked. TEs are highly experienced primary teachers and leaders with a mathematical subject and pedagogic expertise beyond the norm of primary classroom teachers. TEs received additional PL from the research team and remained involved in the project implementation for at least three years. Every year of the project implementation, each TE was allocated between two and four school teams of F-2 teachers (approx. 3-16 teachers per school depending on the school size) to assist in their implementation of the sequences and the associated EMC³ teaching approach.

The research questions were: (1) What were the most notable changes to teacher practices resulting from their involvement in the project? (2) Why did teachers vary in the degree of change and the time it took to adapt to a student-centred inquiry approach?

Method

Participants and Data Collection Process

Participants in this study were five TEs. Working closely with teams of teachers to plan and implement the project in classrooms, they were ideally placed to comment on teachers' adaptation to the new practices inherent in the approach. At the end of the first year of the project's implementation, each TE was individually interviewed for approximately one hour to gain their perspectives on the project's strengths and shortcomings. One aspect of this semi-structured interview focused on changes to teacher practices that the TEs perceived. For example, TEs were asked to comment on practices teachers used to launch challenging tasks, to elicit student thinking and conduct class discussions as they supported student learning. They were also asked to: (a) describe how these practices had changed over the time of the project's implementation; and (b) provide their perspective on the reasons for variations in teacher adaption to the approach. All interviews were audio recorded and transcribed for later analysis.

Data Analysis

Interview data were analysed thematically using an adaptation of Braun and Clarke's (2006) approach. A process of reading for familiarity, followed by coding using both deductive and inductive means before identifying themes that helped capture the notable features of the data that were considered most relevant to addressing the research questions. For instance, we approached coding the interviews knowing that we were interested in the reasons for variations in time and intensity of teacher adaption to the approach advocated during the PL component of the project. However, we did not know which practices or aspects of the approach teachers would find more challenging to adapt to and why.

Results

In this section, we briefly identify the most notable changes to teacher practices that TEs perceived took place during the project. We then identify the themes and sub-themes that emerged from the analysis of interview data that helped to explain the variations in the degree of change and in the amount of time individual teachers or teams of teachers took to adapt to the EMC³ approach. Pseudonyms are used when reporting TEs responses.

All five of the TEs identified “the biggest shift ... has been the pedagogy of launch, explore, summarise and holding back from telling” [Athena]. Elise estimated that “80 per cent of the teachers I am working with are launching without telling or at least trying” and Athena thought that “75% of them are on board and doing a great job with the launch ... holding back from telling.” Although the biggest shift in practice had been teaching “without telling,” Diane felt that it was “different for all the teachers” and that “the launch phase” without telling “was still a challenge for some.” Nancy considered that even though the teachers at one of her schools were already familiar with the lesson structure, the “not telling” was new.

They’ve changed their practice in terms of less teacher talk ... and not doing too much telling. [Nancy]

Thematic analysis of the data revealed two overarching themes in the TEs’ explanations for the variation in time teachers took to adapt to the EMC³ approach—context and teacher agency. Context in space and in time emerged as important reasons why the process of adaptation was “a slow burn” [Athena] or rapid with “big shifts” [Elise] in teacher practices.

Context in space. Variation in the availability of support from their numeracy leadership team members was regularly highlighted as a reason why some teachers found it easier to adapt in their school spaces than others.

They plan their program together; so, there’s three teachers in each space. They’ve got two class teachers and one diversity support teacher, plus the numeracy leader plus the instructional leader; so, it’s many heads, they are very focused. But at School R, which just has the instructional leader, there was several staff who didn’t have much buy-in. there’s been a bit of a staff turnover... Their numeracy leader only has one day [a week], so she’s trying really hard to catch them up to speed. [Athena]

In terms of physical resources, Megan considered that “it’s been really helpful to have the tasks there so they can focus” on the pedagogical approach. However, she realised that sometimes the classroom space itself acted as a constraint for teachers to adapt to new practices when “the room can be noisy, ... it’s a shared space.”

Context in time. Regardless of the rate and extent to which schools and teachers adapted to the approach, the five TEs agreed that individual teachers commenced the project at “different starting points” [Nancy] in terms of their knowledge and practices. Prior PL associated with challenging tasks meant that some teachers could “go deeper with the maths” [Megan] from the start. The variation in teacher readiness to adapt to certain aspects of the teaching approach meant that TEs had to be flexible in how they worked with individuals and groups of teachers.

At School M they were already on this trajectory of deepening teachers’ understanding about math tasks. They had done a lot of professional learning around mathematics already ... At my other school, staff who didn’t have much buy-in had missed out on the professional learning. [Athena]

At my first school ... the kids are used to talking about the maths and used to explaining their thinking and turning and talking to their learning partner. My other school, we’re not at that point yet. We tend to give them some little props sentence starters to get the kids talking ... but they’ve gotten better. [Nancy]

Teacher agency. Teacher agency was characterised by examples of teacher resilience to work (or not work) hard in the face of challenge. Elise remarked that at one of her “slow burn” schools, the teachers showed little agency at the beginning as they “thought all of the tasks ... were too challenging” and “there was no encouragement to try” for many months. Most

teachers, however, were described by TEs as “really working hard” [Megan, Athena and Elise] despite the challenges of adapting to a new teaching approach.

Agency was also exemplified by increases in teacher efficacy. Teachers perceived to be slower in adapting to the approach were described by TEs as initially “hesitant” or “afraid ... of the challenge.” However, “in the doing there has become believing” and growth in the belief that they “could make the approach work.” [Athena]

... it’s been a bit of a slow burn for them. But they are on board; they are positive, and they are thinking that they’re doing a good job. [Elise]

Discussion and Conclusion

In accordance with prior research (e.g., Brunetti & Marston, 2018; Beauchamp & Thomas, 2009), our findings show that context (in space and in time) and teacher agency were central to explaining variations in the time teachers take to adapt to change. Teachers with a strong sense of agency were perceived by TEs to be more willing to work hard and try new practices despite contextual constraints. As the results of this study show, the important point is that teachers must be active in the process of professional learning for any form of change to occur. The findings reinforce recommendations initially expressed by Huberman (1993) and reinforced by Brunetti and Marston that providers of PL need to acknowledge and take account of individual teacher trajectories of learning (context in time) to maximise the potential of teachers adapting to new approaches. In the current study, TEs could adapt to the nature and extent of support individual teachers required. An understanding of school contexts and a sense of individual teacher agency are important to school and system leaders, and to designers of PL to ensure they appropriately respond to the professional needs of teachers.

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