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Editorial

Differentiating Instruction in Mathematics

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Differentiating instruction refers to the variety of strategies that teachers employ as they adapt to the needs of heterogeneous learning groups, the ultimate goal of which is to improve learning for all students. Differentiating effectively is a demanding aspect of mathematics teaching at all levels of education. Expectations around the role of the teacher are shifting, and there is a growing need to incorporate pedagogies that effectively cater to students with diverse academic strengths whilst supporting an inclusive classroom environment (Shernoff et al., 2011). Gervasoni and Lindenskov (2011) argue that there has been a systematic exclusion of all students from high-quality mathematics curriculum because students with disabilities or a history of low achievement experience a deficient diet of mathematics instruction.

Despite its relevance to practice, how teachers attempt to differentiate instruction and how they can be better supported to provide rich learning opportunities for all students remains insufficiently researched. We are currently leading a research project Exploring Mathematical Sequences of Connected, Cumulative and Challenging Tasks (EMC^3; Sullivan et al., 2020). A key aspect of this project is to consider the extent to which teaching with sequences of challenging mathematical tasks can support differentiation in the mathematics classroom, through both low floor/ high ceiling tasks, enabling and extending prompts (Sullivan et al., 2009), and purposeful tasks designed to consolidate learning after productive classroom dialog about solution strategies. Although our EMC^3 project offers one perspective on differentiation through task and learning sequence design, galvanising a broader range of international perspectives on this important topic is valuable. The current special issue includes eleven articles, seven of which comprise author teams based outside Australasia. Differentiation in mathematics is explored from a broad range of angles, including: learning and curriculum design (Bardy et al., 2021; Coles & Brown, 2021; Lambert et al., 2021; Mellroth et al., 2021); assessment (Hopkins & O'Donovan, 2021); small group intervention (Gervasoni et al., 2021); remote learning environments (Courtney, 2021); teacher knowledge (Hubbard & Livy, 2021); and teacher beliefs and practices, particularly in relation to ability grouping (Fitzgerald et al., 2021; Herner-Patnode & Lee, 2021; Webel et al., 2021). We believe collectively the articles in this special issue make a worthwhile contribution to understanding complexities involved in effective differentiation of instruction in mathematics education across various educational levels and contexts.

Differentiation has been an area of interest to all members of the editorial team for a number of years, however undertaking a special issue into this topic now seems particularly timely for two reasons. First, we have compelling data arising from our project that teacher beliefs have shifted, such that most teachers (at least in Australian primary schools) now value learning experiences that provide opportunities for all students to struggle productively in mathematics (Bobis et al., 2019; Russo et al., 2020). Despite this shift in mindset, teachers are often slow to embrace such pedagogies in practice. Better understanding barriers and enablers for supporting the enactment of these beliefs seems of critical relevance in our context. Second, the recent COVID pandemic and the subsequent focus on remote learning has likely exacerbated differences between students, making the need for communicating research conducted into how to best support teachers provide high-quality, effectively differentiated instruction even more pressing. As we commented in a recent article:

> As if differences in style and rates of learning between class members were not already sufficient to create barriers to ongoing learning, the shutdown is likely to have exacerbated those differences… Students who already were, or became, self-directed, persistent, resilient learners may have even been advantaged by opportunities to work with limited supervision. Those who were not so motivated, especially if their parents did not encourage engagement, are likely to have gained less from time away from the classroom. (Sullivan et al., 2020, p. 5)

The varied impact of remote learning on the quality of student mathematical learning certainly presents a pressing and further challenge for teachers, teacher educators and mathematical researchers alike. Indeed, attempting to differentiate effectively in a remote learning environment was a motivating factor for at least two of the studies in the current special issue (Courtney, 2021; Lambert et al., 2021). Courtney (2021) highlights how in a remote learning environment, the specific technologies and resources teachers access to support their instruction are pivotal to how they approach differentiation.

Before proceeding to overview the remaining articles in the current special issue, we thought we would close this introduction by noting one of the persistent tensions associated with effective differentiation: the decision to use homogeneous or heterogeneous student groupings. Heterogeneous groupings most likely place greater demands on the skills of the teacher. Clearly dealing with the extent of diversity that can be expected in most classrooms requires particular lesson structures and learning experiences. Homogeneous groupings assume that students can be grouped validly using one of the characteristics on which students vary. This assumes that the particular characteristic used is more important than others, and that students high on one characteristic are also high on others. Our recent research in an Australian context suggests that most primary school teachers believe that pedagogical approaches that allow for heterogeneous groupings are more effective at differentiating mathematics instruction than homogenous groupings based on assessments of mathematical performance or teacher-perceived mathematical ability. Moreover, participation in our EMC^3 project was associated with a further shift in beliefs concerning the value of heterogeneous grouping practices (Bobis et al., 2021). It is interesting to consider the extent to which primary school teachers in other countries hold such beliefs, and the extent to which these beliefs might shift in response to professional learning opportunities.

Webel et al. (2021) documented how participation in an action research project shifted both the beliefs and practices of four US-based primary school teachers to be more embracing of mixed and random groupings of students when teaching mathematics. The study presents an optimistic picture of how providing opportunities for meaningful collaborative problem solving and group work can support both peer-to-peer learning and generate a positive learning gestalt, whilst challenging student and teacher pre-conceptions about student ability. An even more radical perspective is offered by Coles and Brown (2021), who report on an action research project involving three upper-secondary UK teachers. These teachers, all working with students who had been previously identified as low-attaining and streamed accordingly, were encouraged to pursue mathematical topics assumed to be far beyond the grasp of such students. Coles and Brown (2021) coin this approach “differentiation from an advanced standpoint”, a notion designed to directly challenge the experience of a “circular curriculum” (p. 179). They suggest that the narratives presented by their three study teachers “offer striking alternatives, for students with relatively low prior attainment, to re-visiting the same content, in the same way, year after year” (p. 179).

Although it might generally be assumed that the decision to use heterogeneous or homogenous student groupings in mathematics represents a dichotomy, it is interesting to consider the discussion of the Extending Mathematical Understanding program by Gervasoni et al. (2021) in the current issue. The authors document how this program involved both supporting teachers to teach with one core task differentiated through enabling and extending prompts (Sullivan et al., 2009), whilst also including a targeted intervention designed to provide "intensive differentiated teaching for students who were failing to thrive in mathematics" (p. 214). This additional intensive support was initially effective for closing the gap between these students and the rest of the cohort, although longitudinal data revealed that this gap reappeared 12 to 24 months after the intensive supported ceased.

Fitzgerald et al. (2021) also considered how teachers group students when teaching mathematics, specifically the barriers and enablers to shifting teacher beliefs in relation to ability grouping in their qualitative study involving five primary school teachers in New Zealand. Although some of the teachers in their study certainly shifted their views about ability grouping, the authors noted the persistence of teacher beliefs related to fixed ability levels in mathematics. Whereas focussing on student strengths and collaborative problem solving were identified as enabling factors for shifting teacher beliefs, narrow assessment practices, and teacher preoccupations with such assessments, were viewed as barriers to further shifting teacher beliefs.

It is interesting to contrast the perspective adopted in the Fitzgerald et al. (2021) study with Hopkins and O’Donovan’s (2021) efforts to consider how more nuanced and careful assessment of student thinking can potentially empower teachers to differentiate instruction more effectively. Their study used the Rasch model of measurement to support the development and evaluation of Pocket Money, an app-based tool for assessing the foundational knowledge and competencies essential to understanding money and building financial literacy. Although their sample focussed on adults with intellectual disabilities, both their findings and the Pocket Money tool itself have important implications for primary and secondary school teachers, particularly around how tasks can be adapted so that a broader range of learners can engage with rich learning experiences at an appropriate level of challenge.

Indeed, Bardy et al. (2021) focus on the role of mathematical tasks in supporting differentiation, a perspective that resonates with efforts to support differentiation in an Australasian context (e.g., Sullivan et al., 2009). They examined how teachers compare the differentiation potential of tasks to experts. It was found that teachers were less sensitive in denoting a task as effective or otherwise for supporting differentiation than expert task designers, and tended to be (relatively) more focussed on the surface structure of tasks (e.g., layout) than the deep structure (e.g., specific adaptive features of the task). One potential reason offered is that attending to the deep features of a task to realise its differentiation potential requires specific expertise that teachers need more support in developing.

One means of supporting mathematics teachers become more sensitive to how the deep features of tasks can support differentiated instruction might be to empower them as learning designers. Lambert et al. (2021) designed a course that brought together two perspectives, Universal Design for Learning and Design Thinking, to support teachers in designing high quality mathematics instruction for students with disabilities. It is important to note that these authors took a broader perspective on learning design than focussing on mathematics tasks.

Indeed, reflecting on the implications of their course, they conclude their paper by asking the question: "If educators took up the notion of teacher as designer, and saw themselves as designers of things beyond curriculum, how might they rethink and re-imagine new spaces, experiences, structures, relationships, and systems for students with disabilities?" (p. 73).

Mellroth et al. (2021) also examined the power of positioning teachers as task designers to support differentiation. Their qualitative study, undertaken with eight Swedish upper secondary mathematics teachers, acknowledged the complex and multi-faceted nature of this work by explicitly focussing on contradictions and tensions that emerged within a Professional Learning Community focussed on developing tasks for differentiated instruction. Three dilemmas were highlighted: guiding versus funnelling; introduction versus enrichment; and generality versus specificity. The authors refined a developed task analysis guide, which they proposed for facilitating the navigation of these dilemmas by future professional learning teams of mathematics teachers engaged in task design.

Beyond expertise in task design specifically, teacher experience and knowledge more broadly are fundamental to supporting effectively differentiated mathematics instruction. Herner-Patnode and Lee (2021) presented evidence from their longitudinal qualitative study of pre-service teachers that the capacity to differentiate is connected to levels of teaching experience. They noted that differentiation responsiveness improved between students' third and fourth year of their course, specifically in relation to process differentiation and responsiveness to community culture. Interestingly, however, the authors noted a gap between what participants were able to aptly articulate when discussing student learning needs and backgrounds when reflecting on their perceived practice (reflective commentary) compared with what was overtly incorporated into their planned practice (lesson plans). This connects with our own research noting that changes in mathematics teaching practice often lag behind shifts in teacher mindset (Bobis et al., 2019). To some extent, this disconnect may reflect under-developed, or insufficiently interconnected, Mathematical Knowledge for Teaching. In fact, the importance of Mathematical Knowledge for Teaching for planning and enacting differentiated instruction is examined by Hubbard and Livy (2021) in the current special issue through Hubbard's lens as a mathematical learning consultant, which included supporting teachers on the EMC^3 project.

This volume offers diverse and evidence-based perspectives on differentiating instruction in mathematics – each of which give priority to the learning of individuals and classes collectively. Taken together, the articles exemplify the power of data collection on the impact of practice. Whatever organisational structures and pedagogical practices are adopted, we urge schools and planning teams to articulate their goals for inclusion and gather evidence using the plentiful data available in schools to evaluate the extent to which their goals are achieved.

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