Working Towards Equity in Mathematics Education: Is Differentiation the Answer?

Glenda Anthony
Massey University
g.j.anthony@massey.ac.nz

Jodie Hunter
Massey University
j.hunter1@massey.ac.nz

Roberta Hunter
Massey University
r.hunter@massey.ac.nz

In this position paper, we review the practice of differentiation – a universal concept aimed to support diverse students in our classrooms. In exposing the wide-ranging practices of differentiated instruction, and critiques of current implementation, we argue that differentiation in the mathematics classroom needs to be reframed in terms of a social justice perspective. In doing so, we argue that differentiation practices need to move from a focus on cognitive achievement/performance outcomes that serve to divide/label students towards a focus on student well-being and productive mathematical disposition.

Ensuring that every student experiences maximum opportunity to learn is a goal promoted through differentiation within Australasian curricula and policy documents. However, in our review of the literature, we find that differentiation, whether at the structural school level, or the more student-focused level of the classroom, is a slippery concept. Slippery in terms of goals, teacher understanding, and practice within mathematics classrooms. A contestable term in relation to its contribution to socially-just practices in education, Mills, Keddie, Renshaw, and Monk (2017) posit that differentiation can act both as "a lever for progressing the case that schools can do more for their most vulnerable/marginalised students", and also be "deployed as a device to reinforce the politics of reproduction and the stratification of schooling to maintain the privileges of the powerful groups in society" (p. 2). With this concern as our starting point, this paper critically reviews the differentiated instruction literature, beginning with an overview of the origins and promoted frameworks. We then review studies that explore the effectiveness of differentiated instruction in classrooms. Noting evidence of mixed impact, we review some of the concerns about aims and implementation and look to recent studies that argue for an expanded interpretation of differentiation. To conclude, we offer examples from mathematics classrooms involved in the New Zealand *Developing Mathematics Inquiry Communities* (DMIC) professional learning to warrant claims that a more socially justice aligned vision of differentiated instruction is needed than is currently the case.

Differentiated Instruction: Origins and Frameworks

The concept of differentiated instruction can be seen as a philosophy and a praxis of teaching. Emerging from reform efforts aimed to individualise education in order to achieve equity (Valiandes, Neophytou, & Hajisoteriou, 2018), early beginnings of differentiated instruction aligned with theories such as Vygotsky's Zone of Proximal Development and Garner's theory of multiple intelligence. Sometimes presented as an umbrella term for the collection of measures that interact with differences between students, the literature includes a range of alternative strategies (e.g., differentiated assessment, inclusion, student-centred, individualised instruction, adaptive instruction, personalised learning, and Universal Design

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for Learning). Of note in the early literature is the focus on ways to 'cope' or 'deal' with diversity, and therefore differences between students (Suprayogi, Valcke, & Godwin, 2017).

In the last two decades, a focus on responding to increasing diversity among learners has led to calls for differentiated instruction, both in Australasia and internationally, with Tomlinson's (2014) model of differentiated instruction being the most widely cited approach. Put simply, Tomlinson's (2014) model is based on the premise that learners are different and learn differently. Taking these differences into account requires modification to curriculum-related elements—content (what students learn), process (how they learn), and product (how they demonstrate learning)–all of which are based on three categories of students' needs and variance—performance and readiness, interest, and learning profile (e.g., intelligence, personality or motivation). Tomlinson and Imbeau (2010) contrasted the strategies you might use with students described as having less-developed readiness (e.g., direct instruction methods) versus those you would use with students labelled as advanced (e.g., implementing complex, open-ended, non-routine, and advanced tasks).

While still based on adapting aspects of instruction to differences between students, broader approaches include modifications of student groupings, learning goals, teaching times, or instructional strategy (van Geel, Keuning, Frèrejean, Dolmans, van Merriënboer, & Visscher, 2019). The influence of recent data-driven policies is evident in Roy, Guay, and, Valois's (2013) description of differentiation as "an approach by which teaching is varied and adapted to match students' abilities using systematic procedures from academic progress monitoring and data-based decision-making" (p. 1187). This notion of structural grouping of students by ability as a form of differentiation will be critiqued in later sections.

Application of Differentiated Instruction

Amidst growing calls for differentiation, the nature of differentiation, its interpretation, and implementation remain controversial. Differentiation models in the literature distinguish between proactive and reactive differentiation, and between convergent and divergent differentiation. Here the application of differentiation relates to the implicit or explicit learning goals of teachers with convergent differentiation referring to practices in which teachers define minimum goals with the focus on reducing the variation in performance within the classroom. In contrast, divergent differentiation mainly involves teachers helping all students reach their highest potential, dividing attention equally between students with lower, average, and higher ability (Prast, Van de Weijer-Bergsma, Kroesbergen, & Van Luit, 2015). In practice, most teachers would have a mix of goals (Park & Datnow, 2018).

Drawing on a consortium of Dutch teacher educators' recommendations, Prast et al. (2015) proposed the following model for readiness-based differentiated instruction (Figure 1). Based on a mix of progress monitoring and instructional adaptations, it is notable that the first step in Prast et al.'s (2015) cycle involves achievement grouping based on results of testing. Such an approach is reminiscent of diagnostic testing advocated within the New Zealand Numeracy Project (Ministry of Education, 2008). Of note, is that experts in the Dutch study outlined that modifying learning content and instructional adaptions would mean that:

> in general, low-achieving students need more guidance (e.g. explicit instruction) and instruction at lower levels of abstraction (e.g., using blocks to represent and calculate a sum) while high-achieving students need more exploratory instruction about advanced content with a focus on conceptual understanding (e.g. the relation between multiplication and division). (Prast et al., 2015, p. 99).

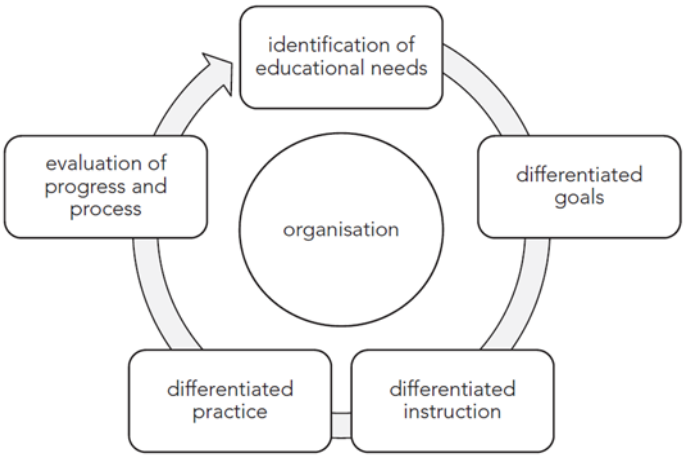

Figure 1. Prast et al.'s (2015) cycle of differentiation model.

Research on the effects of differentiated instruction is patchy. In mathematics education, Goddard, Goddard, and Kim (2015) found positive links between differentiated instruction and students' mathematics achievement, and Tieso's (2005) focus on ability grouping practices claimed greater student engagement. However, Deunk, Smale-Jacobse, de Boer, Doolaard, and Bosker's (2018) meta-analysis of 21 (post 1995) studies on language and mathematics primary education noted that best practices for differentiated instruction inconsistently explained effects and were too often reliant on 'tips and tricks' or a 'tangle of techniques', with little or no evidence-base.

Inconsistency around the effectiveness of differentiation appears in part due to the fuzziness of the construct, which is further complicated by the study of different forms of differentiation and different effects. For example, Deunk et al. (2018) focused only on the cognitive effects of differentiation. While they found that "differentiation had a small overall positive effect on students' academic performance" (p. 42), the researchers noted that between and within-class homogeneous grouping types of differentiation practices appeared to have a small negative effect for low-achieving students and no significant effect for average and high-ability students – a finding they described as "discouraging".

Other studies (Mills et al., 2017; Park & Datnow, 2018; Smyth, 2018; Stollman, Meirink, Westenberg, & van Driel, 2019), focused on the role of policy and school reform efforts, have noted the impact of data-driven policies on teachers' decision making and beliefs about differentiated instruction. For example, Smyth's (2018) research on curriculum differentiation in lower secondary schools in Ireland noted that "the ceiling set on students' achievement by differential access to higher level subjects coupled with a climate of low expectations in middle and lower stream classes was found to have profound [negative] consequences" (p. 50) – consequences that reinforced class differences and students' educational pathways.

Studies around professional learning show that a shift in thinking about differential instruction can be challenging (Goddard & Kim, 2018). Teachers' framing of students who struggle can impact their efforts and interpretation of differentiation practices. For example, Anthony, Hunter, and Hunter (2017) described how some teachers involved in professional learning, designed to support moves to mixed ability grouping, initially perceived their implementation of heterogeneous grouping as a way to have higher performing students assist lower performing students. A view in contrast to the desired aim of supporting students of varied capabilities to engage in critical thinking and complex problem solving together.

Dilemmas Within Current Practice

Stemming from the gamut of research indicating widespread ambiguity about the effectiveness of differentiation practices, there is a growing body of critique that questions the prevalent assumption that differentiation promotes quality education. In this section, we focus on the arguments put forth in the literature that highlight shortcomings in current practices. Critiques are focused on the contribution that differentiation has, or could make, to advancing the agenda of social justice through education. Bannister (2016), like others, argued that while some features of differentiated classrooms are universally valuable "many of the framing ideas for this approach are incongruent with an inclusive education strategy" (p. 337). Her critique surfaced four problematic aspects of differentiated instruction.

The first is the much-touted assumption and research-observed practice that those students labelled with 'less developed readiness' need direct instruction and routine practice, whereas those labelled as 'advanced' should receive inquiry-based pedagogical approaches (Anthony & Hunter, 2017; Denessen, 2017; Suprayogi et al., 2017). Endorsement of this practice–that learners are different and learn differently–is seen in the debates in Australia around the advocacy for schools with high Indigenous populations to adopt a Direct Instruction approach to teaching mathematics (Ewing, 2011). Likewise, in the Australian context, Spina's (2018) study of two schools (a primary and secondary) noted divergence of pedagogical practices for top and lower stream students.

Bannister's (2016) second concern focused on the perpetuation of the myth of learning styles, a practice she claimed is essentialised in the numerous publications by Tomlinson. The concerns of deficit theorising in regard to deficiencies in school-readiness attributed to parents and home circumstances (Tomlinson, 2014) has been widely noted in Australasian mathematics classrooms (Bills & Hunter, 2015; Jorgensen, 2018).

The third critique, shared by others (see Boaler, 2014), is that differentiated instruction frequently, explicitly or implicitly, promotes pseudo within-class ability grouping practices. Noting that many texts on 'how to' differentiate suggest that teachers will create different levels of expectations for tasks and products for groups of students, Bannister (2016) argued that the viewpoint that "some students have more to contribute and are expected to contribute more than others while others are less capable and have less to contribute" (p. 340) is likely to become a self-fulfilling prophecy where low status student contribute very little.

The last critique centres on the possibility that differentiation practices that position students along a continuum of learning, disabled to highly advanced learners, continue to frame academic diversity as problem rather than a position of strength. This highlights, in our view, the most insidious but real possibility of continuance of systemic deficit framing (Hunter & Hunter, 2017). In New Zealand, deficit theorising of Pāsifika and Māori students mirrors the long history of marginalisation through inequitable schooling practices—including a curriculum positioned within the cultural capital of the dominant European group and cross-cultural misunderstandings (Berryman, Lawrence, & Lamont, 2018).

A further, related critique relates to the current audit cultures of schools where ruling relations use logics based on the importance of using educational data to: ensure quality, to differentiate instruction, and ultimately to improve data for individual students and the school (Mills et al., 2017; Spina, 2018). However, research has found that the use of accountability data within high-stakes, limited resource environments can be associated with negative practices of focusing attention on students "on the bubble" (Park & Datnow, 2018, p. 283) and narrowing the curriculum. In New Zealand, Thrupp and White's (2013) research into the mathematics National Standards [withdrawn in 2018] found that some primary schools were using targeted, triage support for particular groups. With "most effort being put into those children who were just 'below' and who relatively easily could be shifted to

'at'" (p. 23) as a strategy to meet targets for National Standards reporting. Again, the likely effect was to deny the lowest attaining students productive mathematical opportunities.

Moving Forward

It is a given that in any mathematics classroom we will have students at different points in their development who bring a wide range of experiences to their learning. Providing students with a quality and equitable education, within these messy and unpredictable contexts, requires teachers to be adaptive, flexible, creative, and caring in their instructional approach. To achieve this, this review alerts us to the need to re-examine the nature of these adaptions – at policy, school, curriculum, and pedagogical levels. We, and others (Alenumas-Mimoh, 2012; Bannister, 2016; Denessen, 2017) argued that differentiation needs to be reframed in terms of a social justice agenda focused on embracing student differences rather than 'dealing' or 'coping' with student difference, and in many cases student limitations.

Here we can learn from the multicultural education equity movement that values academic, cultural, spiritual, and physical wellbeing as educational outcomes. In the New Zealand context, Averill (2018) and Berryman et al. (2018) advocated for culturally responsive pedagogy that respects diversity and understands "students' potential for learning and growth through the exploration of those differences" (Berryman et al., 2018, p. 7). Indeed, working in the multicultural education space, Kieran and Anderson (2018) and Valiandes et al. (2018) proposed frameworks for blending intercultural education with differentiated instruction. In a similar way to the advocacy of responsive and cultural pedagogy proposed by Berryman et al. (2018), their frameworks promotes the dual goal of the celebration of students' cultural backgrounds and individual academic success. In practice, this translates to differentiated lessons where:

> teaching values draws upon all students' lived experiences in order to overcome the pathologies of silence about difference (including those of ethnicity and class) and work explicitly to replace deficit thinking with deep and meaningful relationship. (Valiandes et al., 2018, p. 393).

In the mathematics education context in New Zealand, *Developing Mathematical Inquiry Communities* [DMIC] is a professional learning initiative that also embraces cultural difference within the differentiation space. Drawing on Complex Instruction (Cohen & Lotan, 2014) and culturally responsive teaching, DMIC teachers support students to engage in mathematical practices within collaborative, inquiry community settings. Creating an equitable environment, where diverse students are positioned as competent and capable, is reinforced through the adaptive and culturally appropriate use of the *Communication and Participation Framework* (Hunter, 2008).

In developing a safe learning environment and embedding norms such as active listening and asking questions, careful consideration is given to the cultural values and beliefs of the diverse students. In practice, teachers often use cultural metaphors to shape the interactions—for example, being "in the same waka", working together to craft "siapo" (a type of Samoan bark-cloth), or supporting each other like members of a "whānau/fanau". In many classrooms, the term 'friendly arguing' is used when students are pressed to engage in negotiations, challenges, and explanations as part of mathematical argumentation practices. As one teacher explained to her students:

> It's not just about listening and asking questions, it's about asking those questions that ask "Why?," that push everyone's thinking. And you may disagree. But remember it's friendly arguing; you are arguing about the thinking and not with the person.

Flexible and purposeful grouping allows students to work with a range of peers to focus on specific mathematical skill development and a range of valued outcomes–including

student voice and agency, pro-social skills, mathematical dispositions, and valuing of the mathematics within the home and cultural context. In shifting to instruction that is purposeful, responsive, and respectful to the lived life of students, one teacher noted:

> Until we started to bring these types of problem they didn't make those links and they saw maths as something they did at school that was not relevant. The biggest concept for our kids to know is maths is everywhere … it is not just for maths time. …we practise that with our family…we practise this in our church and in our community so when they make those links and can tie it into…Maths is part of my culture…the value of maths changes and the ideas that maths is hard or alien or random changes as well.

Collaboration in heterogeneous group work means that learning moved from traditional concerns about individual difference to understandings of inclusivity and working with others to build collective meaning. As one student described it:

> We are all different, we all have different ideas and encourage each other to say our ideas and put them altogether and make new knowledge for each other.

Within DMIC classrooms, students openly express awareness and appreciation of diversity in terms of mathematical learning:

> It's good because you hear other peoples' opinions. You have other people to ask you questions, challenge you and help you when you're struggling.

Supporting learning through enabling students to shift between their first home language and English is another example of differentiated instruction that provides equitable access to problem tasks and mathematical talk. Elaborating on the power of code switching one teacher noted:

> It's really powerful if they can use their own language because sometimes it might just be that they don't understand the question … or there might not be a word in English that represents what they are talking about or they might be more confident speaking Samoan or Tongan and then others can translate. Without that, like in the past those kids didn't have a voice and you would just think they couldn't do it.

The provision of sufficient 'think (wait) time' with norms of students providing conjectures, responding to questions, and examining the thinking of others, means that teachers validate confusion as a natural part of sense-making, and normalise that learning mathematics involves effort and sometimes struggle. Mathematical errors or partial understandings provide a valuable window into students' thinking–a dynamic assessment opportunity.

Differentiated instruction that values students' strengths raises teacher expectations, with frequent teacher reports in the first year of DMIC professional learning of 'surprises', particularly with regards the quality of thinking. Alongside increased teacher expectations, we see students in DMIC classrooms developing productive dispositions and agency. Across the multiple instances of the DMIC professional learning program, it is evident that implementation of instructional practices to maximise opportunities for diverse learners requires advanced teacher subject knowledge, pedagogical skills, and classroom management skills. In particular, DMIC teachers talk about developing new relationships with mathematics and mathematics teaching. (Re)forming beliefs about who can do mathematics–with all students viewed as entitled and able to engage in mathematical reasoning–aligns with teachers' press to challenge students to engage in more demanding mathematics; valuing of students' thinking and experiences; and provision for more time to think and express mathematical thinking during collaborative problem-solving experiences.

Conclusion

Teaching in culturally and academically diverse classrooms requires that we address socio-political, psychological, and instructional factors that influence students' success and social inclusion. In this paper, we proposed a blended approach of culturally-responsive teaching and differentiation of instruction that challenges the deficit framing, too often used by education systems regarding school failure. Adopting a more "ethical orientation" (Valiandes et al. 2019) requires that teachers move from an exclusive focus on the cultivation of knowledge towards practice that is inclusive of students' moral, emotional, and social development. Specifically, for teachers, many of who have perceived maths as a values-free subject (Hunter & Hunter, 2017), it is crucial that a framing of outcomes for diverse students acknowledges the importance of culturally informed mathematical dispositions and identities. Only when these principles inform our differentiation practices will we take strides toward achieving education that is socially just and academically responsible for more students.

Our DMIC experiences affirm Valiandes et al.'s (2019) claim that "teacher professional development is necessary to help teachers respond to these complex roles by implementing culturally sustaining pedagogy through interculturally differentiated teaching" (p. 349). In addition, we argue that it remains vitally important to continue to research how teachers proactively and rationally support differences between students, and "how they differentiate unconsciously and intuitively" (Denessen, 2017, p. 11), and in what contexts? There is still much to learn to inform a vision of on how to support diverse learners.

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