Symposium: Attending to Student Diversity in Mathematics Education in Inclusive Settings

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Classrooms worldwide are becoming increasingly diverse. The term 'diversity' is contextual and often ambiguous. At a foundational level, 'diversity' is a descriptive term that refers to individual differences and needs (Forghani-Arani et al., 2019). The type of individual differences varies to include the following dimensions "migration, ethnic groups, national minorities and Indigenous peoples; gender; gender identity and sexual orientation; special education needs; and giftedness" (OECD, 2023, About us section). The OECD definition captures a range of individual differences, but it is essential to recognise that these differences can occur simultaneously, be intersecting, and often inseparable. In this way, an individual could have multiple dimensions of diversity in which they differ from others.

The multi-dimensionality or 'hyper-diversity' recognises the "intense diversification of the population, not only in socio-economic, socio-demographic and ethnic terms, but also with respect to lifestyles, attitudes and activities" (Tasan-Kok et al., 2013, p. 8). We adopt the term 'hyper-diversity' to refer to students who have multiple dimensions of diversity. In light of growing student diversity, there is a need for more research (Rigney & Rinaldi, 2023). We would extend this claim to students who are 'hyper-diverse'. This symposium showcases different dimensions of diversity, focusing on students with diverse needs in inclusive mathematics education. The papers explore students with diverse needs from the early primary years to post-secondary schooling, highlighting the importance of inclusiveness across the lifespan.

Chair: Kate Quane.

Paper 1: *Reflecting on the school mathematics experiences of adults with Down Syndrome*.
Matt Thompson, Catherine Attard and Kathryn Holmes.

Paper 2: *"Look at solutions": Differentiated instruction (DI) in senior secondary mathematics.*
Lorraine Gaunt and Tom Porta.

Paper 3: *Participation in mathematics for a student with blindness or low vision in Australian mainstream schools: A longitudinal case study*.
Melissa Fanshawe and Melissa Cain.

Paper 4: *Opportunities for hyper-diverse students to communicate their mathematical thinking in multi-year classes.*
Kate Quane and Bec Neill.

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"Look at Solutions": Differentiated Instruction (DI) in Senior-Secondary Mathematics

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Differentiated Instruction (DI) is a philosophical and pedagogical approach supporting diverse student engagement in learning, but limited research exists in DI in senior-secondary mathematics. Using semi-structured interviews, the perceived use of DI of two senior secondary mathematics teachers was investigated. One of three themes is discussed in this paper; using strategies to enable student choice and voice. Results indicated teachers used various DI strategies to support students to understand their current levels of need, allowing student choice in their tasks, and supporting student reflective practice. DI in senior-secondary mathematics is complex, but achievable.

Differentiated Instruction (DI) is a widely researched framework supporting teachers to attend to student diversity. Teachers do so by adjusting instruction to suit student need, taking a proactive (Tomlinson, 2014) and responsive approach (Tomlinson, 2022) based on data-driven teaching. There is a paucity of research, however, in DI practices and implementation in mathematics classrooms, specifically in senior-secondary mathematics. Australian teachers are required to differentiate for their students (Australian Institute of Teaching and School Leadership [AITSL], (2017). Thus, understanding how successful teachers use DI in senior secondary mathematics is imperative. DI is not reactive but takes a responsive approach to meeting the needs of diverse learners in one's classroom (Tomlinson, 2022). While research on DI has increased in the last 20 years (Sun & Xiao, 2021), research on DI and mathematics in senior-secondary education is scarce, with studies focusing on DI in primary (Fitzgerald et al., 2021) middle or lower secondary education (Pozas et al., 2023). In a special issue of *Mathematics Teacher Education and Development* (Russo et al., 2021) that focused on differentiating instruction in mathematics, only two of 11 articles were on senior secondary mathematics differentiation (Coles & Brown, 2021; Mellroth et al., 2021). While Coles and Brown (2021) discussed three teacher's reflections of the process of DI in their senior secondary classes, Mellroth et al. (2021) studied eight mathematics teachers in Sweden who taught university mathematics preparation courses in years 10–12. Mellroth et al. (2021) discussed how teachers collaboratively planned a problem bank of challenging tasks to be implemented in their classes, but no discussion of classroom implementation was provided in either paper. Given van Geel et al. (2019) outlined that teachers struggle to differentiate instruction, research highlighting effective DI practices in senior-secondary mathematics classrooms is timely. Student enrolment in Year 12 mathematics subjects has dropped in Australia (Australian Mathematical Sciences Institute [AMSI], 2020). Given research outlined that DI is one way to engage students in learning, determining how teachers use DI for learners in senior-secondary mathematics may support more teachers in implementing DI, ensuring success of mathematics students. This study investigated how two teachers implemented strategies in their mathematics classrooms, to answer: What teacher-developed DI strategies are senior-secondary mathematics teachers utilising in their classroom, to cater for learner diversity?

Methodology

This study was conducted at two independent schools in Australia, Adelaide, South Australia, and Brisbane, Queensland. Part of a wider study, this paper reports on two senior secondary mathematics teachers. Maria (pseudonym) with 20+ years' experience, taught Essential Mathematics in South Australia (Government of South Australia, 2016). Julia (pseudonym) with 10 years' experience, taught Mathematical Methods in Queensland

(Queensland Curriculum & Assessment Authority, 2019). This study aims to compare the DI strategies used in senior-secondary mathematics. Case studies allowed the first author to gain an understanding of the practice of DI (Creswell, 2012). Using purposeful sampling, data were collected using semi-structured interviews to elicit detail of DI, as a philosophical practice, in classrooms. Data were analysed according to the six steps reflexive thematic analysis (Clarke & Braun, 2021), which included researchers familiarising themselves with data, reading and conducting member checks. Researchers coded data inductively and deductively, according to the framework by Tomlinson (2014), ensuring interrater reliability during joint coding.

Results

Three themes constructed from data were (1) Strategies to enable student voice and choice in mathematics; (2) Supporting the process of learning, not just content of mathematics; and (3) DI is for all students and takes time to master. Here, the first theme will be explored. Both teachers were efficacious in using DI, both identifying several effective strategies. These teachers taught two mathematics subjects individually, that both target different levels of mathematical ability, but data from interviews with both teachers showed similarity in their strategies to implement DI, even within the difficult confines of the inflexibility of senior secondary mathematics. Strategies identified by both teachers within this theme have been delineated into three sub themes; (1) Strategies supporting students to see themselves as mathematics learners; (2) Strategies giving students choice that led to student success; and (3) Strategies supporting student voice using reflections and feedback.

Theme 1.1: Strategies Supporting Students to see Themselves as Mathematics Learners

Both teachers felt supporting students to see themselves as capable mathematics learners was vital. Julia said, "every kid walks out of my classroom feeling like they can do something" and from Maria, they "don't feel like maths failures anymore. I can successfully convince them that they do have a mathematical brain". In Mathematical Methods, Julia created a safe space where students feel empowered to try even if they were wrong. She said students were not afraid to be wrong because "that's the place [the classroom] to be wrong, and who cares if you're wrong? We can fix wrong". To cultivate this safe space, Julia encouraged student collaboration, stating "it gives the students who are able to carry on, on their own, access to each other as well to push each other, and I think that is almost more important than any teacher driving anything". Similarly, Maria encouraged collaboration in her classroom stating that when students learn from each other, "they can reinforce their own learning in class". This leads to "that beautiful moment, when you teach something to a kid and they're really enjoying learning it" and when they share that learning with others, "it empowers them". Hence, teachers felt supporting students to see themselves as mathematics learners was empowering.

Theme 1.2: Strategies Giving Students Choice That led to Student Success

Both Julia and Maria differentiated instruction within their classrooms by providing choice for students. Strategies included starter questions, colour coding questions into different levels, providing extra resources such as videos and weblinks, formative assessment tasks, regular feedback, exercises with multiple destinations, group work, and students teaching each other. Both teachers saw value in providing student choice. Julia indicated formative assessment tasks and starter questions enabled students to select the most appropriate level to work, stating "lessons I make are created so that the kids have a say in what they're doing and … help them decide what levels they're at". Maria would "*look at solutions*, ways of presenting things to kids that enable them". She suggested "having multiple destinations in the exercise, they make the choice. They push themselves to their limit". Both teachers outlined students responded to choice in their learning by working harder and they had seen improvements in students' success.

Julia stated she saw "what they're doing very regularly", and Maria said "they came away with extra skills themselves. They really enjoyed learning from one another". Thus, teachers believed, strategies which gave students choice, led to student success.

Theme 1.3: Strategies Supporting Student Voice Using Reflections and Feedback

A more recent strategy that both teachers had employed was student self-reflection, which allowed students to deepen their own understanding. Julia provided students with feedback on work booklets and students then completed a self-reflection sheet. Julia stated that self-reflection was "helping them develop their own understanding of exactly where they are". Maria used open ended problem tasks and asked students to reflect on the process. She felt that this deepened student learning. For example, in an open-ended geometry task where students needed to develop a product, Maria asked students "to explain why the construction worked". Additionally, Julia differentiated her instruction by facilitating classroom discussions where she could support or extend student thinking "because I think for maths particularly it's incredibly important for development of understanding". Therefore, self-reflections and feedback were identified as supporting student voice.

Discussion

We recognise that DI is more than just a series of strategies, however, one must have a repertoire to differentiate effectively. The results highlighted that these two efficacious senior secondary mathematics teachers used a variety of differentiation strategies that focused on supporting students to understand the current levels of need, allowing student choice in their tasks and approaches, and in supporting student reflective practice to deepen student learning. The use of a variety of strategies aligns with the results from Smets and Struyven (2020) who found that DI can quickly be seen as just a series of strategies. While true in the case of these two teachers, the use of a variety of strategies contributed to greater student voice being included in the differentiated classroom. Importantly, teachers were asked questions beyond DI strategies, including, for example, using differentiated resources and tasks. The use of tiered assessments, one of the most applied DI practices (Smit and Humpert, 2012), were not highlighted. Therefore, tiering may not be as applied in senior-secondary mathematics classrooms. Julia and Maria both cultivate supportive classroom climates where students felt comfortable to "have a go" and it was "okay to make a mistake". Students collaborated, often participating in group problem solving tasks, teaching each other, or revising and testing each other. Teacher planning supported students to make choices and work through the material at their own pace and students chose materials and resources that best supported their learning. Even within the perceived inflexibility of senior-secondary mathematics curriculum, both teachers stated they found ways to use DI and support student learning. Hence, while teachers worldwide are struggling to differentiate (van Geel et al., 2019), the results from this study extend the findings of van Geel et al. (2019), by outlining that teachers make DI work, within the constraints they perceive they have. As Julia stated, with the restrictions on assessment and content, "the only thing we can change is the instruction and the support behind it" and in that regard, both Julia and Maria successfully used DI and supported their students. Limitations in this research included the small sample size, teacher participants were female, taught in independent, all-girls schools, and self-reported DI strategies. The teachers taught different levels of mathematics, but demonstrated remarkably similar approaches to DI. Future research warrants a broader sample across school systems.

Conclusion and Recommendations

As student numbers in senior secondary mathematic decline, it is possible students may not be engaging in higher level mathematics because teaching does not meet their needs. These two exemplary teachers demonstrated that DI in the senior-secondary classroom is both possible

and necessary to improve student outcomes. This calls for further investigation into how exemplary practices like these can be shared through professional learning activities to ensure both greater enrolment in senior secondary mathematics and better student support.

Acknowledgments

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