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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Opportunities for Hyper-Diverse Students to Communicate Their Mathematical Thinking in Multi-Year Classes

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This paper examines the mathematical experiences of students with additional and diverse needs in multi-year classes within the educational context of small regional South Australian (SA) schools. Qualitative research methods were used to collect data about how students communicate their mathematical thinking. Opportunities for students to communicate their mathematical thinking were categorised using Bruner's experiential stages of learning. Findings suggest that the collaborative nature of multi-year classes fosters peer learning and cooperation, enabling students to share and build upon each other's mathematical thinking.

One way that student diversity is evident is in students attending small schools. Students attending small schools can be arranged in composite, multi-age, multi-year, or stage classes (Cornish, 2010). Often, these terms are used interchangeably but each refers to a specific structure and rationale for the organisation of students. Cornish (2010) describes the formation of multi-grade (or multi-year) classrooms due to low student and/or teacher numbers which are predominately found in rural locations. The number or years within one class will be determined by the number of students and can include all students from all primary years within the one class. In contrast, Cornish (2010) describes composite classes "formed by necessity" due to the annual variation in student enrolment within particular year groups (p. 8). In this way, composite classes are a result in fluctuations in student numbers and are temporary. A third way to organise students is in multi-age classes whereby students are not associated with a year, rather the classes are flexible based on choice (Cornish, 2010). According to Cornish (2010) multi-age classes can be known as "non-graded classes" or "family classes" and students "have no association with a grade, nominal or otherwise" (p. 8). Rather the classes are structured so that they are "developmentally appropriate" tailoring the curriculum to "allow for continuous progress in learning" (p. 8).

The paper reports on an aspect from a larger study that explored optimising early mathematical learning experiences and establishing positive attitudes towards and experiences of mathematics for young South Australians attending small regional schools. In SA, 70% of small schools are in regional or remote locations, typically characterised by multi-year classes whereby two or more consecutive curriculum-year levels are within the one class. This focus responds to enduring inequalities in academic success and lower life opportunities experienced by young Australian children living in regional and rural locations (Thomson et a., 2019). This paper seeks to answer the research question, "What opportunities do students have in multi-year classrooms to communicate their mathematical thinking to others?"

Communicating Mathematical Thinking

Communication is a participatory and cultural process, that is a significant practice in mathematics (van Oers, 2013). The ways in which mathematical thinking is communicated are diverse, interrelated, and can often go unnoticed. Freitas and Walshaw (2016) argue that thinking can happen "without language" but through language, thinking becomes more sophisticated (Freitas & Walshaw, 2016, p. 20). Mathematical thinking is often communicated verbally or in written form. While these two forms of communication are predominant features in communicating mathematical thinking, there are other multi-modal forms that students can use to communicate their thinking (Quane & Booth, 2023). Numerous curriculum documents and standards emphasise the importance of developing student's mathematical thinking. One

Australian jurisdiction that elaborates on the communication of mathematical thinking is the New South Wales Education Standards Authority (NESA, 2021), which provides a general description of students communicating mathematical by describing, representing, and explaining "mathematical situations, concepts, methods, and solutions to problems, using appropriate language, terminology, tables, diagrams, graphs, symbols, notation, and conventions". From this description, we can see that communicating mathematical thinking involves several processes including representing, describing, and explaining through using appropriate language, terminology, and conventions.

Method

The participatory action research was conducted in two small regional South Australian state schools with two junior primary teachers. Site 1 had 35 student enrolments with 17% of students (six) identifying as Aboriginal or Torres Strait Islander. The 35 students were arranged in two classes, a junior class comprising of Reception (first year of school), year 1, and year 2 (n = 15), and an upper class of students in years 3 to 6 inclusive. Site 2 had 45 students enrolled and arranged in three classes, a Reception and year 1 (n = 13); a year 2 and 3; and a year 4–6 inclusive. Both sites had high proportions of students with additional learning needs and diagnosed disabilities.

Data was collected using children's drawings, semi-structured interviews (n = 16), and 20 classroom observations to ascertain how students in multi-year classrooms communicated their mathematical thinking. The participating students were diverse in terms of their gender (5 females, 11 males), their special education needs (50% of students with a formal diagnosis of a form of neurodivergence, 1 child with an intellectual disability, 3 children with delayed speech) or their giftedness with 1 child from site 1 being accelerated in mathematics, attending the year 3–6 class. In addition, students at both sites experienced higher levels of socio-economic disadvantage adding another dimension of diversity. Further, children also completed a task co-designed between the two teachers and two researchers. Data analysis occurred atomically and holistically, initially viewing each data source separately and then collectively using an open-coding process to identify emerging themes. Bruner's (1966) experiential stages of learning classified as enactive, iconic, and symbolic were used to analyse the opportunities for students to communicate their mathematical thinking.

Findings

Opportunities for students to communicate their mathematical thinking were classified into three broad themes: (1) opportunities to represent mathematical thinking; (2) opportunities to describe and explain their thinking; and (3) opportunities to use appropriate language, terminology, and conventions. In this paper, the first theme of representing mathematical thinking will be discussed. Bruner's (1966) experiential stages of learning have been used to elaborate on the first theme with this paper paying particular attention to the iconic stage.

We report on an observation conducted at Site 1 where all students engaged in the same mathematical task and the resultant opportunities provided by the teacher for students to communicate their mathematical thinking. Students were given numerous opportunities to represent their mathematical thinking during all three experiential stages, with greater opportunities for representations occurring during the enactive and iconic stages. The enactive representations lead to students describing what they have represented which aided the transition from the enactive to iconic representations. The task (Figure 1) explored the concept of additive patterns and was displayed on the interactive board. The teacher organised a range of iconic representations including buttons and pom poms to represent the decorations. The teacher read the task and gave explicit instructions on the materials and group expectations. Students were grouped into three mixed-year-level groups. Figures 2 and 3 show two different student group representations created collaboratively. At the mid-point of the learning experience, the teacher gathered the students around each group's representations and asked students to share what they had done and why (Figure 6). Students were then encouraged by the teacher to use the strategies that were shared by their peers. Students had further opportunities to develop and refine their representations (Figures 5 and 6) before a final sharing opportunity was instigated.

Figures 1–6

Task Description (1), Students Representing their Thinking (2 and 3), Sharing their Thinking (4), and Final Representations (5 and 6)

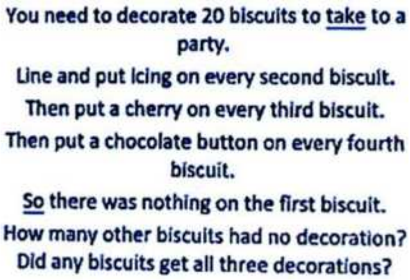

Figure 1

Figure 2

Figure 3

Figure 4

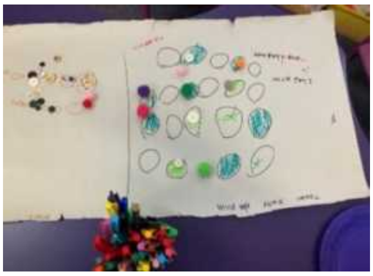

Figure 5

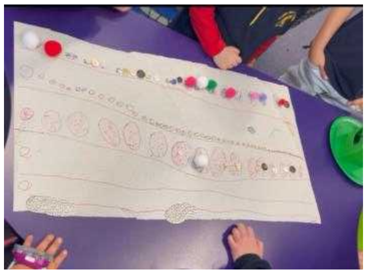

Figure 6

Discussion

The student-co-constructed representations were great opportunities for students to communicate their mathematical thinking to their peers and their teacher. In developing their constructions, students used multiple forms of communication including gestures, the use of manipulatives, and assistive technology. The familiar objects (Larkin, 2016) of buttons and pom poms provided opportunities for students to create representations that could then be later used to aid students in describing and explaining their mathematical thinking. Students combined iconic representations, drawing circular shapes for the biscuits with the familiar objects. The use of diagrams (Larkin, 2016) was a key feature of all iconic representations providing further opportunities to share mathematical thinking. The student-generated diagrams led to a class discussion about the suitability of the diagrams, with one student adamant that the only way to represent the 20 biscuits was in lines.

The two multi-year classes that were the focus of this study were rich in examples of the many opportunities afforded to students to communicate their mathematical thinking. The engagement with peers of different ages provided numerous opportunities to use and engage in multiple representations and hear and see different descriptions and explanations. Peers acted as enablers, motivators, and collaborators (Quane, 2021) whereby students sought help from their peers and to share ideas. Students actively contributed to the ideas of other students, building on or adapting their thinking or adopting the thinking of others, thereby, enabling and fostering students' mathematical thinking. Through facilitating sharing opportunities, the teacher provided further opportunities for students to observe and listen to other students' thinking, cultivating the classroom norms to share and collaborate. The multi-year structure of the classes provided opportunities for students to hear a variety of explanations that may be beyond their curriculum year level. As such, they provided opportunities for greater exposure to how mathematics develops including but not limited to mathematical language which in turn provides further opportunities for students to communicate their mathematical thinking. In selecting the task (Figure 1), the teacher provided students with an authentic scenario that was relatable to the children. Further, the investigation style of the lesson provided another layer of opportunities for students to communicate their mathematical thinking. Students were given opportunities that were planned by teachers while other opportunities to represent mathematical thinking spontaneously occurred, introduced by both teachers and students.

Conclusion

The paper highlights the invaluable opportunities for hyper-diverse students to communicate their mathematical thinking within the unique context of multi-year classes in small regional SA Schools. The findings underscore the significance of providing students with multiple opportunities to represent their mathematical thinking using various modalities together with the nature of multi-year classes fostering peer learning and collaboration, enabling students to share and build upon each other's mathematical thinking. Teachers play a crucial role in facilitating these opportunities by creating a supportive learning environment and selecting authentic tasks that resonate with students' lived experiences. By harnessing the power of multi-modal communication and peer interaction, educators can empower hyper-diverse students to develop confidence, agency, and a deeper understanding of mathematics, ultimately promoting equitable access to mathematical learning and success. Moving forward, continued research is required into the practices used in multi-year classes to better understand the complexities of these settings.

Acknowledgments

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