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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Rigney, L.-I., & Rinaldi, C. (2023). Teaching in cultural and linguistic super-diverse Australian classrooms: A north–south exploration of Reggio Emilia. In B. Fyfe, Y. L. Lee-Johnson, J. Reyes, & G. Schroeder Yu (Eds.), *Affirming the rights of emergent bilingual and multilingual children and families: Interweaving research and practice through the Reggio Emilia Approach* (pp. 209–225). Routledge.

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Participation in Mathematics for a Student With Blindness or Low Vision in Australian Mainstream Schools: A Longitudinal Case Study

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Students with blindness and low vision (BLV) are less likely to choose mathematics as a subject in the senior secondary years which may negatively impact future employment opportunities. Using a longitudinal qualitative methodology, three interviews were recorded with a student who is legally blind over a six-year period. Findings suggest that access to mathematics curriculum and assessment was significantly impacted. Use of assistive technology and support from others enabled increased participation and achievement in this subject. Independent access to the curriculum and use of assistive technology may lead to students with BLV choosing mathematics in senior secondary.

Participation in mathematics for students in schools has been previously found to develop the required attitudes, knowledge, and skills to gain entry to Science, Technology, Engineering, and Mathematics (STEM) careers (Nitzan-Tamar & Kohen, 2022). This is important as STEM offers some of the highest employment opportunities within the world labour market. Further, mathematics is an essential component of many professions which require employees to understand numbers, solve problems, and apply critical reasoning (Just & Siller, 2022). Barriers to accessing mathematics learning have been previously documented based on gender, ethnicity, and disability. Students with blindness or low vision (BLV) face unique challenges within classrooms, due to the curriculum being designed for those who can see (Fanshawe & Jones, 2021). Curriculum materials such as writing on the board, handouts in class, textbooks images, and videos can be inaccessible, along with symbolic representations such as graphs, diagrams, symbols, shapes, and patterns. Inability to access classroom materials presents as challenges for BLV students, if students are not given agency to access and participate in learning (McLinden et al., 2016). With approximately 4,000 Australian students with BLV, this paper is guided by the research question: What factors does a student with BLV perceive as impacting participation in mathematics learning?

Methods

Qualitative methodology was considered the most useful to answer the research question, to examine participation in mathematics in Australian Schools for students with BLV (Calman et al., 2013). The longitudinal case study presented in this paper concerned one student with the pseudonym of Kye, who was known to the researchers and thus recruited through convenience sampling. Kye was interviewed once at the end of primary school (Year 6), once in secondary school (Year 9) and again in senior secondary school (Year 11). Three different interviewers were used over the project and member checking was used to ensure validity in reporting of results. In each interview, Kye was asked questions which aimed to elicit information about participation in mathematics in the classroom. Transcripts of the recordings were checked for accuracy by Kye and his parents and uploaded into NVivo. Tools within NVivo were used to identify main themes using inductive category development (Mayring, 2000) and then to categorise qualitative data examining the contextual changes over time.

Results

Kye attended a local government primary school and a Catholic secondary school. Kye had a congenital vision condition with clouding on his cornea and nystagmus with a medical diagnosis of counting fingers at 70cm, which meant he was legally blind. Kye described his vision “the most I can see is one metre away, but it’s cloudy and shaky” and in a later interview,

"I like to say I'm legally blind so other people know I can't see much at all. If I say I have low vision, they think I just need glasses or something".

Accessibility of Mathematics in Primary School

Concrete materials were used in primary school which Kye reported helped aid his understanding of mathematical concepts, "if my teachers are talking about a cube, they give me a cube so that I can feel the sides and corners and angles". He also received worksheets "blown up in large print". He stated, however, he still needed magnification such as a handheld dome magnifier, a digital magnifier, and CCTV camera to enlarge the worksheets. Furthermore, he had an iPad, which he used to take photos which he used to magnify images on the board and worksheets. When completing tests, Kye reported that it took him a lot longer than his peers. The "hardest part is that I can't see all the numbers in one spot, so I have to look at one number and go back and look at the next". He explained that he would have a teacher read out the question, then "I write the numbers down really big so I can remember them". Despite using technology, he shared that mathematics was "difficult to access information". He would ask friends to read out questions and "I'd remember numbers in my head".

Technological devices such as a screen reader and an electronic braille device were used by Kye to access information in subjects such as English, however, he reported that these technologies were not as useful in mathematics as "there are lots of pictures and shapes". He explained that his friends and teachers could not use screen readers or read braille and it took a long time to find information; "and it's difficult to go back in braille to find something, you have to read it all again". To access images, shapes, and graphs, Kye was provided with tactile diagrams, which were created on a "PIAF which gets all the ink on the paper that is black and raises it up so you can feel it". Teachers and support staff assisted Kye to access mathematics in diverse ways including using thick pens on the board which made the magnified image on his iPad clearer, giving verbal instructions, and reading out what they wrote on the board. Kye spoke of an advisory teacher who supported his classroom teachers and a teacher aide who taught him braille and created his enlarged worksheets. Despite not all aspects of the mathematics curriculum being accessible, and exams taking additional time, Kye shared his love of mathematics and provided examples of ways he was able to access mathematics.

Accessibility of Mathematics in Secondary School

Microsoft OneNote, which is a digital note-taking tool used by Kye's school to store and organise class content, increased independent access to mathematics in secondary school for Kye, "the teacher in maths, instead of writing on the board, he does it in OneNote". He explained that teachers uploaded mathematics curriculum materials into OneNote, which meant Kye could use a braille device, magnification, or a screen reader to read out the online content at the same time as his peers. Kye stated the benefit was that "everybody has OneNote, not just me". The benefits to the class were further acknowledged "the teacher writes on OneNote, and we all have access, but [the teacher] isn't standing in front of the board, so everyone can see. Then I sit at the back and zoom in on my iPad". Kye's textbook was downloaded in digital format, accessible on iPad Pro. Tactile diagrams were common again in secondary school, with many PIAFs being created by the teacher aide, particularly for graphs and images. Kye was also provided with 3D models created on the school's 3D printer.

Internal examinations were created in a word document using a table and equation editor, which was accessible with braille, magnification, and a screen reader, and allowed Kye to tab through the fields to access content. Kye explained that he received an additional half an hour in time for every hour of exam, "but I need every minute of it to access the test". Kye preferred to work independently in class. Support from teachers was appreciated in creating accessible materials for OneNote and consistent training in assistive technology was provided by the

advisory teacher. Kye reported that he performed well in the exams and was selected in an advanced enrichment mathematics class.

Accessibility of Mathematics in Senior Secondary School

At the time of the third interview, Kye was engaged and performing well at school, however, it was reported he was no longer using braille and had withdrawn from Senior Maths Methods. He reported, "OneNote kept glitching. I had no idea what was on the board. By the time the teacher came to help me, I had missed a double lesson of information and had no idea how to catch up". When asked why the OneNote had changed from previous years, Kye suggested ICT support didn't prioritise his access. Further, Kye shared senior secondary examinations were created externally which meant that previous accessibility was no longer available. Teachers in the school would make the examinations accessible for Kye by providing equations, graphs, and images in alternate formats. However, despite additional time provided, Kye reported exams being "too frustrating as I just ran out of time". He said this reflected in his marks. Kye shared that while he had tried to remain enrolled in Maths Methods, it "took me too long with all of my other subjects", resulting in Kye withdrawing midway through the year.

Discussion

This case study identified that the mathematics curriculum and assessment was not inherently accessible for a student BLV, which is concerning given the goal for the Australian education system to promote equity and excellence. Successful adjustments included accessing information from the board, textbooks, and worksheets through simple solutions such as verbal descriptions of what were on the board, along with assistive technology including magnification, braille, and screen readers to access digital information. McLinden et al., (2016) shared the importance of students being able to access materials independently, to ensure agency in learning, such as Kye's use of OneNote. When items were not able to be accessed independently, support people within the school assisted to create accessible content.

Advances in assistive technologies have increased opportunities for students with BLV to independently access the mathematics curriculum. For Kye, digital technology provided ways for digital textbooks and documents to be accessed using screen readers, magnification tools, and an electronic braille device. When digital documents were accessible and the technology was working, Kye's participation was enabled. However, inequities in access to assistive technologies for students with BLV (Fanshawe et al., 2023) can further emphasise the gap in achievement in mathematics for these students. In Kye's case, the secondary school seemed willing, capable, and equipped to use inclusive technologies, and implemented recommendations to support access from an advisory teacher from outside the school. However, when technology was not connecting, and documents were not formatted Kye experienced barriers to participation in mathematics. Although additional time was provided in examinations this was not always sufficient for Kye and as a result his grades were not necessarily indicative of his knowledge. Similarly, Al-Dababneh et al. (2015) found that barriers to participation in mathematics could mask academic potential. This is indeed problematic, as Nitzan-Tamar & Kohen (2022) report that learning experiences in classroom mathematics have a potential to impact university selection and employment outcomes.

Support from others also positively impacted Kye's participation. Kye reported the school utilised an advisory teacher and all his teachers were willingly trying to make access inclusive. Whitburn (2014) asserted that pedagogical practices were important for inclusion in schooling as the teacher's ability to normalise differences within a class could decrease the stigma if all students had access to the curriculum and pedagogy. Kye reported that he preferred the teacher aide to support his access through the creation of accessible curriculum and assessment, rather than sit with him in class. This aligns with the study of Byrne (2014) who found students

resisted the assistance of a teachers' aide as this meant they had decreased control over their learning or looked different to their peers. Independence in accessing mathematics information was an important enabler for the student in this study.

Conclusion

The qualitative case study highlighted that the standardised curriculum and assessment provided was not always accessible for all students in Australian mainstream schools. The longitudinal data from three interviews of one student in in primary, secondary, and senior secondary school contexts showed barriers to accessing mathematics for BLV students. While materials which were formatted digitally and use of assistive technology provided greater independence to the student, many essential elements of mathematics, such as images, diagrams and graphs were not able to be accessed independently. When the student not able to independently participate in mathematics learning, teachers and external experts provided modification to access learning and teaching materials. Unfortunately, this case study also showed, that barriers in access for students can take additional time and frustration, which ultimately led to attrition from mathematics subject by student who is blind. Advances in technology and reconsideration of accessibility embedded in the curriculum is essential to provide excellence and equity in education for all students. It is hoped that further research will identify needs of BLV students in the classroom, resulting in increased participation in mathematics and more equitable access to STEM careers.

Acknowledgments

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