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

Kate Quane
University of South Australia
kate.quane@unisa.edu.au

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.

References

Forghani-Arani, N., Cerna, L., & Bannon, M. (2019). *The lives of teachers in diverse classrooms*. OECD Education Working Paper No. 198. OECD Publishing, Paris. https://doi.org/10.1787/8c26fee5-en

OECD. (2021). *TALIS 2018 results* (Vol. I). OECD. https://doi.org/10.1787/1d0bc92a-en

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.

Tasan-Kok, T., Kempen, R., Raco, M., & Bolt, G. (2013). *Towards hyper-diversified European cities: A critical literature review*. Utrecht: Faculty of Geosciences, Utrecht University.

(2024). In J. Višňovská, E. Ross, & S. Getenet (Eds.), *Surfing the waves of mathematics education. Proceedings of the 46th annual conference of the Mathematics Education Research Group of Australasia* (pp. 49–65). Gold Coast: MERGA.

Reflecting on the School Mathematics Experiences of Adults with Down Syndrome

Matt Thompson
Western Sydney University
matt.thompson@westernsydney.edu.au

Catherine Attard
Western Sydney University
c.attard@westernsydney.edu.au

Kathryn Holmes
Western Sydney University
k.holmes@westernsydney.edu.au

This paper reports on a section of a larger study, investigating the mathematics experiences of Down syndrome (DS) learners in Australian Primary Schools. Developing the numeracy skills to experience independence in post school settings is crucial for individuals with DS. The aim of this paper is to share the school mathematics experiences of six DS adults and their parents/carers to ascertain if their experiences (DS adults) with mathematics when they were at school have had consequences for how they engage and participate in society as adults. Initial findings suggest that DS adults' mathematics experiences have impacted on their quality of life in a post-school setting.

Down syndrome (DS) is the most commonly occurring chromosomal disorder in Australia with 1 in every 1100 births resulting in a DS diagnosis (Miller, 2015). Individuals with DS often have an intellectual disability and experience significant developmental delays. At the beginning of the 21st century, research alluded that most individuals with DS would struggle and have difficulties with learning mathematics (Bird & Buckley, 2001). Fortunately, contemporary research highlights the need for encouraging further mathematics education research, aiming to find new ways to bring positive mathematics experiences to this population (Faragher & Gil Clemente, 2019). This need is grounded in the fact "that mathematics can contribute, like other disciplines (language, theatre, sports) to the holistic development of people with DS especially with respect to thinking skills and awareness of the world" (Faragher & Gil Clemente, 2019, p. 112).

Importance of Positive Mathematics Experiences

Many individuals in society have a negative disposition towards mathematics as a result of their experiences with the subject at school. These experiences can be the result of teachers not having the pedagogical content knowledge in mathematics to design mathematics experiences for students that are substantively engaging, purposeful, and relevant to students' lives, and that are reflective of the individual needs of each student (Martin et al., 2009). Consequently, sustained student engagement, attainment of the subject in the later years of schooling as well later career choices are all factors that have the potential to be negatively impacted as a result of students' adverse experiences when learning mathematics (Bourgeois & Boberg, 2016). Interestingly, this research is usually only undertaken with students without intellectual disabilities in mainstream schools.

However, it can be argued that negative experiences in mathematics, leading to negative consequences in adult life could equally be as applicable and devastating to students with intellectual disabilities. Specific to individuals with DS, developing the appropriate numeracy skills needed to be able to function in, contribute to, and make sense of the world in which they live is crucial for them to experience independence, develop a sense of purpose, and function as a member of wider society (Faragher, 2019).

Methodology

Snowball sampling was used to recruit six DS adults and their parents/caregivers to participate in a joint semi-structured interview. Interview questions were designed to garner the perspectives of these individuals and their parents/caregivers about their mathematics experiences when they were at school. The methodology literature that explores research in marginalised contexts, highlight the importance of not interviewing those with disabilities in isolation. Kelly (2007) attests to this notion and states that “gaining access to marginalised groups may be difficult, and that, in the case of those with disabilities, it is likely to be necessary to gain access through gatekeepers” (p. 24) such as parents/caregivers. The DS adult participants were given the option to provide their own informed consent (n = 1) or have their parents consent for them (n = 5) and to participate in their own separate interview (n = 0) or to be interviewed with their parents (n = 6).

Findings

This section reports on the findings from the interviews of each participant group (pseudonyms used), made up of the DS adults and their parents/caregivers. Thematic analysis underpinned by Brofenbrenner’s ecological model (1994) was used to analyse interview data.

Participant Group One—Michael and Tania

Michael is twenty-two years old and completed school four years ago. He was in a support unit that was in a mainstream public school for both primary and secondary school. When reflecting on Michael’s school experience with mathematics, his mother, Tania said, “They [school] probably could have done a bit more … expanded on it [mathematics] instead of just limiting him, because now he is probably working at a year two level … I can see it now … his understanding is still not great.” Tania also acknowledged in the interview that she felt that Michael was never challenged with his learning, “I found that they [school] almost expected him to be behind and not be able to do things, this was completely the opposite for my other kids, if they were struggling with something at school, I was told straight away.”

Participant Group Two—David and Kate

David is 24 years old and completed school six years ago. He was home-schooled for his first year of school, then attended a support unit in a public school for Year 1 and Year 2. Due to negative experiences with his teacher and class during this time, David’s mother, Kate enrolled him in a mainstream Catholic school where he attended from Year 3 until Year 12. When asked about David’s school experiences with mathematics and how his learning in mathematics has impacted on his life now in a post school setting, Kate said, “If I hadn’t got myself educated, he’d still be struggling … not knowing the days of the week … not knowing the time of day … these are the things that are foundational to be able to function in the world.” It was evident when interviewing David and Kate at their home, that Kate has invested an enormous amount of time since David has finished school, trying to teach David basic mathematics concepts such as time, money, addition and subtraction so that he can experience some independence in society.

Participant Group Three—Cooper, Lauren and Renee

Cooper is 23 years old and completed school five years ago. He attended a support unit in a mainstream public school for kindergarten; however, like David, encountered negative experiences with his teacher. As a result, his mother, Lauren enrolled him in a support school for the remainder of his school career. Lauren stated in her interview that Cooper “loved school, but it wasn’t until later on that we realised that he didn’t learn a lot at school … my daughter, Renee taught him how to read and write … he learned so much after he left school.” Lauren also stated that “he [Cooper] just never understood anything to do with maths. Counting, money, time he doesn’t understand that.” Cooper’s sister, Renee spoke about Cooper not understanding weather predictions. She gave the example of when it is forecast to be cold and raining, Cooper would get himself dressed in shorts and a t-shirt. She said, “we’ve had big issues with this … it is really frustrating for him now that he is an adult." Lauren also stated in the interview when discussing the basic numeracy skills needed to be able to independently function in society, "all those skills, he [Cooper] really didn't get them at school, which is a shame, because now he really does struggle." Like David, it appears that Cooper's experiences with mathematics at school, have also impacted on his ability to be able to function independently, now that he is an adult.

Participant Group Four—Kim, Joanne and Robert

Kim is 35 years old and completed school 17 years ago. She was in a mainstream class in a mainstream public school for her primary years of schooling and was enrolled in a support unit in a mainstream public high school for her secondary schooling. When asked about the importance of mathematics in Kim's life now that she has finished school and lives independently, Joanne and Robert spoke about the important role that Kim's schooling had in her learning of mathematics. Joanne said, "we were lucky, in those days we had lots of support in the classroom, we only had to get on the phone and say, Kim needs help with this, and the support was there." Kim spoke about her ability to be able to independently budget her money each week and proudly showed her weekly budgeting folder. When asked if these skills were something that Kim learnt at school, Joanne said "it was learnt at home, Kim taught herself how to do those things because she wanted to be independent."

Participant Group Five—Evelyn and Alison

Evelyn is 30 years old and completed school 12 years ago. She was enrolled in a support unit in a mainstream public school for both her primary and secondary schooling. Alison spoke of a teacher that Evelyn had in her primary school years, Mrs Peterson. She said "Mrs Peterson, is one of those people that should be cloned … she was unbelievably fantastic, I felt like between them [Evelyn and Mrs Peterson] that they reached so many goals." Interestingly, Alison also said when discussing Evelyn's mathematics experiences, "I felt like it [mathematics] didn't get anywhere, but I didn't expect it to because there was so much other stuff to concentrate on … we were trying to get language and reading happening." Alison also said that she felt that mathematics plays a rather large role in Evelyn's life now, that she is in a post school setting. Similarly, to David, Cooper, Kim and Noah, Alison stated that "most of her [Evelyn's] mathematics has been learnt since she finished school."

Participant Group Six—Noah, Melissa and Jackson

Noah is 36 years old and completed school 18 years ago. He attended a mainstream class in a Catholic school for his primary school years; however, due to negative experiences with teachers and other students, Noah's parents, Melissa and Jackson decided to enrol him in a supported setting in a Catholic school for Year 7 through to Year 12. Noah's parents spoke about their negative experiences encountered when Noah was in primary school. They said they "felt pressured to send Noah to a mainstream school" and stated when talking about the teachers' aide that supported Noah that "they were there to take him out of class, so that the rest of the class could get on with it and he did kind of whatever." Like Michael and Cooper, it appears that Noah also experienced limited opportunities. Similarly, to Cooper and David's experiences, Noah's parents also expressed the amount of work they have done since Noah has left school, to try and support him in developing his independence, "even at the start of this year, we were trying to teach Noah how to read and understand time." When asked, if they thought if Noah's mathematics skills were the result of what he learned at school or at home, Noah parents said, "it's definitely been more home-based than school-based."

Discussion and Conclusion

Analysis of interview data has revealed that irrespective of the type of school that was attended by the adult participants with DS when they were at school, negative mathematics experiences at school were commonplace, except in the case of Kim. These negative experiences appear to have manifested themselves into ongoing problems for this population and their parents/caregivers, navigating the world in a post-school setting. It appears that low teacher and school expectations in relation to mathematics were evident among most participants. Contrary to this were Kim's experiences; however, she too has had to learn the numeracy skills needed to experience independence, since leaving school. Similarly, all parent/caregiver participants expressed similar experiences relating to having to teach their child mathematics at home, after finishing school, to try and give them the opportunity to independently access society. Not having the opportunity at school to develop the skills needed to be prepared for their role as a community and workforce members (Education Council, Australia, 2019) is "disheartening and frustrating" as expressed by one parent. This paper contributes to our knowledge of the impact of negative school mathematics experiences on the quality of life of adults with DS navigating the world in post-school settings. It is imperative that more research be conducted to ensure that current and future DS learners in Australian schools, be given the opportunity to experience positive mathematics throughout their school career, developing the appropriate skills needed to prepare them to be able to engage, post school, as informed numerate citizens.

Acknowledgments

Ethics approval was granted by the Western Sydney University Human Research Ethics Committee (Approval number H15357). Parents/caregivers gave informed consent for themselves and where applicable, for their child to participate in this study.

References

Bird, G., & Buckley, S. (2001). *Number skills for individuals with DS an overview*. Hampshire: The DS Educational Trust.

Bourgeois, S., & Boberg, J. (2016). High-achieving, cognitively disengaged middle level mathematics students: A self-determination theory perspective. *Research in Middle Level Education), 39*(9), 1–18. https://doi.org/10.1080/19404476.2016.1236230

Bronfenbrenner, U. (1994). Ecological models of human development. *International Encyclopedia of Education, 3*(2), 1643–1647.

Education Council, Australia. (2019). *Alice Springs (Mparntwe) Education Declaration*. Australian Government.

Faragher, R. (2019). The new 'functional mathematics' for learners with Down syndrome: Numeracy for a digital world. *International Journal of Disability, Development and Education, 66*(2), 206–217. https://doi.org/10.1080/1034912X.2019.1571172

Faragher, R., & Gil Clemente, E. (2019). Emerging trends in mathematics education for people with DS: Current research and future directions. *International Journal of Disability, Development, and Education, 66*(2), 111–118. https://doi.org/10.1080/1034912X.2019.1579891

Kelly, B. (2007). Methodological issues for qualitative research with learning disabled children. *International Journal of Social Research Methodology, 10*(1), 21–35. https://doi.org/10.1080/13645570600655159

Martin, A., Marsh, H., McInerney, D., & Green, J. (2009). Young people's interpersonal relationships and academic and non-academic outcomes: Scoping the relative salience of teachers, parents, same-sex peers, and opposite-sex peers, *Teachers College Record, 111*, Article 15593. http://www.tcrecord.org/

Miller, P. (2015). *DS*. Cavendish Square Publishing LLC.

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

Tom Porta
The University of Adelaide
tom.porta@adelaide.edu.au

Lorraine Gaunt
Charles Sturt University
lgaunt@csu.edu.au

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

Ethics approval was granted by the University of Southern Queensland Human Research Ethics Committee (Approval number H21REA101).

References

Australian Institute of Teaching and School Leadership (AITSL). (2017). *Australian professional standards for teachers*. AITSL. https://www.aitsl.edu.au/standards

Australian Mathematical Sciences Institute (AMSI). (2020). *Maths crisis: Year 12 maths enrolments reach all-time-low*. AMSI https://amsi.org.au/2022/04/27/maths-crisis-year-12-maths-enrolments-reach-all-time-low/

Clarke, V., & Braun, V. (2021). *Thematic analysis: A practical guide*. London: Sage

Coles, A., & Brown, L. (2021). Differentiation from an advanced standpoint: Outcomes of mathematics teachers' action research studies aimed at raising attainment. *Mathematics Teacher Education and Development*, *23*(3), 166–181.

Creswell, J. (2012). *Educational research planning: Planning, conducting, and evaluating quantitative and qualitative research*. Boston, MA: Pearson.

Fitzgerald, L., Hunter, J., & Hunter, R. (2021). Shifting teacher practices in relation to grouping: Gap gazing or strengths focused approaches. *Mathematics Teacher Education and Development*, *23*(3), 97–110.

Government of South Australia. (2016). *Essential mathematics 2023 subject outline stage 1*. https://www.sace.sa.edu.au/web/essential-mathematics/stage-1/planning-to-teach/subject-outline

Mellroth, E., Bergwall, A., & Nilsson, P. (2021). Task design for differentiated instruction in mixed-ability mathematics classrooms: Manifestations of contradictions in a professional learning community. *Mathematics Teacher Education and Development*, *23*(3), 78–96.

Pozas, M., Tovar, J., Guerra, L., Armendariz, L., & Zubiria, A. (2023). Differentiated instruction in mathematics according to lower secondary school Mexican students. In V. Letzel-Alt & M. Pozas (Eds.), *Differentiated instruction around the world: A global inclusive insight*. Waxmann.

Queensland Curriculum & Assessment Authority (QCAA). (2019). *Mathematical methods 2019 v1.2*. QCAA. https://www.qcaa.qld.edu.au/downloads/senior-qce/syllabuses/snr_maths_methods_19_syll.pdf

Russo, J., Bobis, J., & Sullivan, P. (2021). Differentiating instruction in mathematics. *Mathematics Teacher Education and Development*, *23*(3), 1–5.

Smets, W., & Struyven, K. (2020). A teachers' professional development programme to implement differentiated instruction in secondary education: How far do teachers reach? *Cogent Education*, *7*(1). https://doi.org/10.1080/2331186X.2020.1742273

Smit, R., & Humpert, W. (2012). Differentiated instruction in small schools. *Teaching and Teacher Education*, *28*(8), 1152–1162. https://doi.org/https://doi.org/10.1016/j.tate.2012.07.003

Sun, Y., & Xiao, L. (2021). Research trends and hotspots of differentiated instruction over the past two decades (2000–2020): A bibliometric analysis. *Educational Studies*, 1–17. https://doi.org/10.1080/03055698.2021.1937945

Tomlinson, C. A. (2014). *The differentiated classroom: Responding to the needs of all learners*. Association for Supervision & Curriculum Development. http://ebookcentral.proquest.com/lib/usq/detail.action?docID=1709534

Tomlinson, C. A. (2022). *Everybody's classroom: Differentiating for the shared and unique needs of diverse students*. Teachers College Press.

van Geel, M., Keuning, T., Frèrejean, J., Dolmans, D., van Merriënboer, J., & Visscher, A. J. (2019). Capturing the complexity of differentiated instruction. *School Effectiveness and School Improvement*, *30*(1), 51–67. https://doi.org/10.1080/09243453.2018.15390133

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

Melissa Fanshawe
University of Southern Queensland
Melissa.Fanshawe@unisq.edu.au

Melissa Cain
Australian Catholic University
Melissa.Cain@acu.edu.au

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

Ethics approval was granted by the University of Southern Queensland and the Australian Catholic University Human Research Ethics Committees (Approval numbers H18REA275, ETH2023-0836 & 2018205H).

References

Al-Dababneh, K., al-Masa'deh, M., & Oliemat, E. (2015). The effect of a training programme in creativity on developing the creative abilities among children with visual impairment. *Early Child Development and Care, 185(2)*, 317–339.

Byrne, B. (2014). Getting in and getting on? The experiences of young people with visual impairments and hearing impairments in third-level education. *International Journal of Disability, Development and Education, 61*(2), 119–133. https://doi.org/10.1080/1034912X.2014.905057

Calman, L., Brunton, L., & Molassiotis, A. (2013). Developing longitudinal qualitative designs: Lessons learned and recommendations for health services research. *BMC Medical Research Methodology, 13*(1), 14.

Fanshawe, M., Barton, G., Mandarakas, M., Cain, M., Todd., N. (2023). Enablers and barriers to equitable participation for students with blindness or low vision. *International Journal of Inclusive Education*, 222652991. https://doi.org/10.1080/13603116.2023.2265915

Fanshawe, M., & Jones, A. (2021). Accessible mathematics for students with vision impairments. *Teaching Mathematics*, *46*(3/4), 14–16.

Just, J., & Siller, H.-S. (2022). The role of mathematics in STEM secondary classrooms: A systematic literature review. *Education Sciences, 12*(9), 629. https://doi.org/10.3390/educsci12090629

Mayring, P. (2000). Qualitative content analysis. *Qualitative Social Research, 1*(2). http://www.qualitative-research.net/index.php/fqs/article/view/1089/2385

McLinden, M., Douglas, G., Cobb, R., Hewett, R., & Ravenscroft, J. (2016). 'Access to learning' and 'learning to access': Analysing the distinctive role of specialist teachers of children and young people with vision impairments in facilitating curriculum access through an ecological systems theory. *British Journal of Visual Impairment, 34*(2), 177–195. https://doi.org/10.1177/0264619616643180

Nitzan-Tamar, O., & Kohen, Z. (2022). Secondary school mathematics and entrance into the STEM professions: A longitudinal study. *International Journal of STEM Education, 9*, Article 63.

Whitburn, B. (2014). Accessibility and autonomy preconditions to 'our' inclusion: a grounded theory study of the experiences of secondary students with vision impairment. *Journal of Research in Special Educational Needs, 14*(1), 3–15. https://doi.org/10.1111/1471-3802.12014

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

Kate Quane
University of South Australia
Kate.Quane@unisa.edu.au

Bec Neill
University of South Australia
Bec.Neill@unisa.edu.au

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)

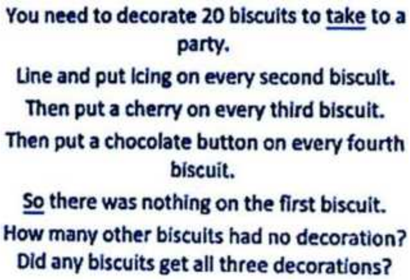

Figure 1

Figure 2

Figure 3

Figure 4

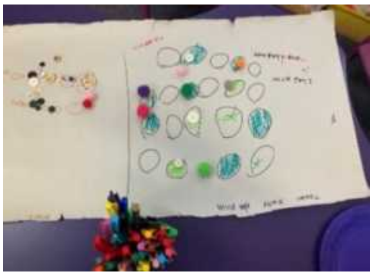

Figure 5

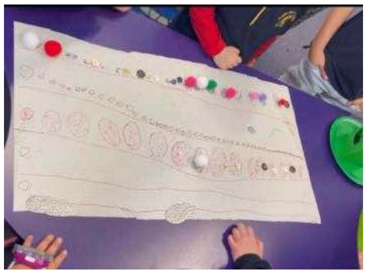

Figure 6

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

This research was supported by a Margaret Trembath Research Scholarship from Early Childhood Australia: SA Branch. Ethics approval was granted by the University of South Australia Human Research Ethics Committee (Protocol Number 204913,) and the SA Department of Education (2022-0062).

References

Bruner, J. S. (1966). *Toward a theory of instruction*. Harvard University Press.

Cornish, L. (2010). Multiage Classes—What's in a name? *Journal of Multiage Education*, *4*(2), 7–11.

Freitas, E., & Walshaw, M. (2016). *Alternative theoretical frameworks for mathematics education research*. Springer. https://doi.org/10.1007/978-3-319-33961-0

Larkin, K. (2016). Mathematics education and manipulatives: Which, when, how? *Australian Primary Mathematics Classroom, 21*(1), 12–1.

New South Wales Education Standards Authority. (2021). *Working mathematically*. NSW Education Standards Authority (NESA). https://educationstandards.nsw.edu.au/wps/portal/nesa/k-10/learning-areas/mathematics/mathematics-k-10

Quane, K. (2021). Curriculum implications of understanding the influence of peers on the nature of young children's attitudes towards mathematics. *Curriculum Perspectives*, *41*, 245–255.

Quane, K., & Booth, H. (2023). Unpacking mathematical thinking: The case of describing and explaining thinking. *Australian Primary Mathematics Classroom*, *28*(2), 21–28.

Thomson, S., De Bortoli, L., Underwood, C., & Schmid, M. (2019). *PISA 2018: Reporting Australia's results. Volume I student performance*. ACER. https://research.acer.edu.au/ozpisa/35

van Oers, B. (2013). Communicating about number: Fostering young children's mathematical orientation in the world. In J. Mulligan, & L. English (Eds.), *Reconceptualising Early Mathematics learning* (pp. 183–203). Springer 183–203.