

Inclusive Practices in the Teaching of Mathematics: Supporting the Work of effective primary teachers

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The practices of effective primary school teachers including students with Down syndrome in their mathematics classes are largely unexplored and many teachers feel unprepared to teach students with intellectual disabilities. A study with cohorts in Victoria and the ACT is underway and here we report a subset of findings concerning the support teachers claim to require. There was an identified need for mathematics specific resources and strategies but a strong endorsement of inclusion as an appropriate practice in primary mathematics.

Introduction

As the focus of teaching has shifted toward a more child centred approach, there is much discussion about how to differentiate both teaching and curriculum to suit the needs of different learners. This is even more pronounced when considering the teaching of children with intellectual impairment within the context of inclusive classrooms. Mathematics teaching has traditionally been approached with an assumption of the development of sequential skills and is seen as a greater challenge to differentiate than other areas of the curriculum. A current research project is investigating practices of effective primary school teachers who were including children with Down syndrome in the teaching of mathematics in the primary school. In this paper, we report early findings from the project that identified the support teachers required to do their work.

Down syndrome is one of the most commonly occurring conditions leading to intellectual disability (Selikowitz, 1997) affecting approximately 1 in every 660 live births in Australia (Centre for Development Disability Health, 2005). In Australia, the majority of these children attend mainstream primary schools and are taught in classrooms alongside their age peers (Gothard, 2010). We have been studying learners with Down syndrome in previous work (Faragher & Clarke, 2014) and became interested in the classroom experiences of these children and the teachers who worked with them. The project described in this paper studied the classroom practices of primary mathematics teachers who were experienced with teaching in inclusive classrooms, as they taught classes including children with Down syndrome. At the start of the project, none of the teachers had taught a student with Down syndrome before. We followed the teachers' journey through a school year and studied a number of aspects of their work. Here we report on the support that these teachers claimed to require to successfully teach mathematics to the learner with Down syndrome alongside the rest of the class.

Literature

Including students with Down syndrome in regular mathematics classrooms has a relatively recent history. In Australia, the Disability Discrimination Act of 1992 and the companion Disability Standards for Education 2005 provided legislative protection to ensure learners with disabilities had the same rights as all other learners in Australia to education in their local school.

2015. In M. Marshman, V. Geiger, & A. Bennison (Eds.). *Mathematics education in the margins* (Proceedings of the 38th annual conference of the Mathematics Education Research Group of Australasia), pp. 173–180. Sunshine Coast: MERGA.

The education provider must take reasonable steps to ensure that the course or program is designed in such a way that the student is, or any student with a disability, is able to participate in the learning experiences (including the assessment and certification requirements) of the course or program, and any relevant supplementary course or program, on the same basis as a student without a disability, and without experiencing discrimination. [Standard 6.2 (1), p. 23, Disability Standards for Education 2005]

With such a recent history of teaching practice, the challenge arises for teachers in the design and delivery of programs such that learners are able to participate and be assessed on classwork alongside their peers. It may be rare for these teachers to have experienced inclusive education in their own schooling. Australian research indicates that the majority of pre-service teachers feel underprepared on graduation for teaching students with special educational needs (Department of Education, Science and Training, 2006). Therefore, opportunities to develop expertise may come largely through experience, and appropriate professional learning will be important at that point. The nature of such professional learning is a focus of the current project.

Inclusive Education

Making adjustments and supporting learners with significant intellectual disabilities in mathematics can take many forms. We were particularly interested in inclusive education practices. We adopted the definition of inclusive education to be the practice of “welcoming, valuing and supporting the diverse learning needs of all students in shared general education environments” (Thousand & Villa, 2000, p. 73).

Inclusive education can be seen as a philosophy, process and practice (Cologon, 2014b, p. xviii). As a **philosophy**, it honours human diversity – all people, without exception, have value and a deserved place in an education setting. We are not doing some a favour; we are welcoming the contribution of all.

As a **process**, inclusive education differs from other processes for educating learners with disability. *Segregation* refers to education apart, such as in special schools or separate classrooms within a school (e.g., a special education unit). *Mainstreaming* (not to be confused with mainstream schools such as local schools, which are those that are not targeted to a specific group) refers to the process of enrolling students in a general classroom setting, but without adjustments or support for the requirements of the learner. Another common approach is *integration* where the student is present and adjustments may be made, but the setting itself does not change. The child who cannot fit in, cannot take part. An example of this approach would be where the child is physically in the same room as the rest of the class but does different work with the assistance of an aide. D’Alessio (2011, p. 102) referred to this as ‘micro-exclusion’. Another commonly used model of integration is the practice of co-location (Slee & Allan, 2001) where students attend some lessons, such as art classes but are withdrawn for other lessons, often mathematics.

As a process, inclusive education is different to segregation, mainstreaming and integration. It involves “both social and academic inclusion, free from discrimination in any form” (Cologon, 2014a, p. 12). How this is done relies on the **practices** of inclusive education. Here the concern is with approaches, strategies and activities that are founded on the philosophy and processes of inclusive education. In our work, we have been particularly concerned with the practices of teachers from the academic inclusion perspective.

Inclusive Mathematics Education

The research literature provides little indication of what happens in inclusive mathematics classrooms. A recently published systematic review of observational research into inclusive education practices (McKenna, Shin, & Ciullo, 2015) identified just five studies published between 2000 and 2013 relating to mathematics classrooms. Observational studies are those that “seek to document how schools utilize instructional procedures based on policy change and research” (McKenna et al., 2015, p. 2).

McKenna et al. (2015) reported a number of findings of mathematics instructional practices documented in the reviewed studies. Each of the five studies observed lessons from the Number strand with very little time devoted to other areas of mathematics, if at all. A second finding attended to support for understanding. Teachers were observed to skip over work that might be thought difficult, and when students required assistance, they were told to try harder or given the answer. One of the studies, by contrast, observed students explaining their mathematical thinking in journals. Overall, observed opportunities for students to verbalise and discuss their mathematics were limited.

The third finding referred to types of instruction. Explicit instruction was observed and is a commonly recommended technique for teaching students with mathematics learning difficulties (Westwood, 2000). The approach was described as “Within a structured class, teachers systematically delivered mathematics lessons using specific procedures—introducing objectives, reviewing previously learned concepts, modeling new skills, and providing guided and independent practice. In this way, teachers applied procedure-based mathematics instruction to support students with LD [learning difficulties]” (McKenna et al., 2015, p. 8). While explicit instruction is considered an important approach by some mathematics education researchers, it is not regarded as solely effective, with researchers recommending a balanced approach including opportunities for strategic thinking and reasoning along with explicit teaching in numerical techniques (e.g., Baroody, 2006).

Another finding of the McKenna et al. review was that only two of the five studies reported observed use of visual support for learning number. As students with Down syndrome generally find support from visual strategies (Couzens & Cuskelly, 2014), it is concerning that visual strategies were not common place in the inclusive classrooms observed in these studies.

With so few studies providing observational evidence of inclusive mathematics education practices, further research is clearly needed. We are unaware of any studies explicitly investigating mainstream classrooms including learners with Down syndrome.

Mathematics Education for Learners with Down Syndrome

In reviewing current understandings of the mathematical development of learners with Down syndrome there are two cautions. First, people with Down syndrome have diverse phenotypes – they are not all alike. In common with other characteristics, educational attainment in general and mathematics attainment in particular, vary greatly from individual to individual. Second, diagnosis-specific knowledge can be a barrier to inclusive practice. This may seem counter-intuitive, but as Cologon notes, this approach can lead teachers to “become focused on the label and not the child, thus they implement inappropriate strategies that do not suit the child” (Cologon, 2014b, p. xix). All the same, there are some common traits exhibited by many

learners with Down syndrome that can be helpful to consider in making adjustments to the mathematics curriculum.

Almost all research into the development of mathematics by learners with Down syndrome has studied aspects of Number. Very few studies from other areas of the discipline exist (Faragher & Clarke, 2014). Considerable difficulties with the development of number concepts have been documented by many researchers (Bird & Buckley, 2001). Unfortunately and incorrectly, many of these authors extrapolate difficulties with number concepts to difficulties with mathematics in general, leading to a very pessimistic view of what might be possible for students with Down syndrome to accomplish. Some studies have emerged (Faragher, 2014; Monari Martinez & Benedetti, 2011; Monari Martinez & Pellegrini, 2010) that suggest that other areas of mathematics, including algebra, may be within the grasp of learners with Down syndrome if they have access to a calculator and have been taught how to use it.

From the reading of the literature, the following aspects were considered important for teachers beginning their work including learners with Down syndrome: a shared understanding of inclusive practice as defined earlier in this paper; an understanding of Down syndrome; effective use of resources in mathematics education, particularly with respect to visualisation strategies; and appropriate use of calculators. In the present study, this was a starting point for our work with teachers.

This study had an overarching research question: What is the nature of inclusive mathematics education for learners with Down syndrome in primary classrooms? Here we report findings on the following sub-question: What are the teacher identified support needs to effectively include a child with Down syndrome in primary mathematics?

Background and Design of the Project

How does the teacher of a Year 4 student who is not able to reliably count a collection of 10 objects productively include the child in the teaching and learning of fractions? Teaching is complex but the challenges in these contexts are even greater. Such students are often assisted by a teacher aide and other advice and support are provided. What does a teacher need to know and be able to do in order to enhance the mathematics learning of children with Down syndrome in inclusive settings? How do teachers balance the needs of a range of children within the regular classroom with external curriculum expectations?

A research project - *Supporting the Mathematics Learning of Children with Down Syndrome in Inclusive Settings* - was conducted in 2014 by the authors, funded by Gandel Philanthropy and undertaken through the Australian Council for Educational Research Foundation, to explore these and related questions.

The project involved two groups of teachers, one in Melbourne and one in Canberra. In Melbourne, schools were identified by education officers of the Down Syndrome Association, were chosen based on their reputation for inclusive practice, and were currently including students with Down syndrome in their programs. In Canberra, links with parents and contacts within the local Down Syndrome Association were used to identify schools where inclusion was being effectively implemented. Parents were initially contacted and once ethics approval was obtained, the schools were approached.

An initial workshop was held at the beginning of the school year in each location, which included both professional learning and project planning. Teaching teams were introduced to a task based assessment interview for students, revised from an

instrument used in a previous project (Faragher & Clarke, 2014). This was intended to be used at the beginning and the end of the year with each child. Relevant research findings on learners with Down syndrome and effective mathematics teaching were shared. We were particularly interested in capturing effective practice. For our study, this involved classroom observations, collection of work samples from students, teacher reflection journals, and interviews with teachers. There was a cycle of professional learning followed by school observation which was undertaken twice over the year of the project. Interviews with the teaching teams after the observations informed the content of the subsequent meetings in the middle of the year. The final meeting of teaching teams was an opportunity to reflect on the year and gather summative data on inclusive practice.

As the study unfolded, it was apparent that teacher participants had a range of expertise with inclusive practice and a variety of approaches were evident. In some cases, not all represented inclusion as defined above. This had implications for support needs which we consider further in the remainder of this paper.

Some Initial Findings

In this paper we focus on the support needs identified by members of the teaching teams at the beginning and again at the end of the school year. Both classroom teachers and teacher aides completed a questionnaire at the first professional development meeting in February and in the final meeting in November. For the initial questionnaire, we prepared two versions – one for teachers and one for teacher aides. Sixteen teachers and 12 teacher aides filled out the initial questionnaire. However, based on the models of inclusion and the varying roles of the aides that were evident through our observations and conversations, we gave the same questionnaire to all team members at the end of year. They were asked however, to note any questions they did not think were applicable to their context and role. Final questionnaires from 22 participants have been analysed to date. A small number of teams or team members were unable to attend the final meeting and these are being followed up at the time of writing.

In the initial questionnaire, teachers were asked the following question: What do you expect to be the most challenging aspect of teaching mathematics to the child with Down syndrome in your classroom? Please provide 3 in order of expected challenge.

The previous item to this had identical wording with the word “mathematics” deleted to elicit general responses, including those related to syndrome specific concerns. It was also designed to ensure that the mathematical focus of this item was reinforced.

A detailed analysis is not included here, but of the 16 teachers, syndrome specific perceptions (such as “stubbornness”) and management focused responses were given as the most challenging by 3 teachers. The remaining 13 teachers identified the major challenge related to mathematics and particularly to planning and teaching for differences.

The teachers were then asked - *What help do you think you need to support the mathematics learning of the child in your class with Down syndrome?* Of the 16 responses, 12 made specific reference to their need for greater knowledge of the mathematics learning of children with Down syndrome, with the next most frequent reference (7) focused on the need for support with resources including planning. Four teachers expressed the need for assessment information and strategies.

In the final questionnaire, after the teaching teams had been working with the child for almost a year, the item on the most challenging aspect was repeated. Overall the responses were more extensive and gave specific reference to the child and their learning. This was to be expected as they now had greater knowledge and experience. For the teachers, need for specific resources (4 responses) and challenges related to the varying mathematical ability of the student (7 responses) were identified as the most challenging. There was an increased emphasis on challenges related to student attitude and behaviour. These clearly had an impact on their teaching. These were not just behavioural and syndrome specific but also related directly to engagement and motivation in mathematics. These were the major challenge for the four other teachers. The following open responses indicate some of the issues involved.

Variations in his engagement to learning - the days where he is wanting to participate vs the days where he is being resistant and not wanting to do anything.

The child's ability to sometimes be able to show their understanding of a concept and not be able to do it on other occasions means that you can never be sure where to start with individual instructions.

The teachers had experienced close familiarity with one of the challenges faced by students with Down syndrome – motivation to engage with learning (Gilmore & Cuskelly, 2014). Teachers were clearly concerned with children engaging with mathematics learning and were not content to allow the learner to opt out. Early work by Wishart (1993) identified the predilection for avoidance of learning by even very young children with Down syndrome. The teachers in our study were determined to not accept this as a situation that was immutable and instead sought support for strategies to overcome this detrimental learning approach.

By the time of the administration of the final questionnaire, the teaching teams had gained considerable expertise and our goal was to tap that knowledge before teachers moved to new classes, most often without the learner with Down syndrome. In the final questionnaire, all participants were asked the following open response question: *What advice would you give others who are including a child with Down syndrome in mathematics classrooms?* The responses are summarised in Table 1.

The advice most referred to (by 11 out of 19 responses) involved the explicit encouragement to emphasise inclusion. Sample responses were:

Include them in the grade and modify if need but never to exclude them as that can affect their learning and confidence.

Children with DS should be included in all sessions. Provide opportunities for the child to complete small tasks independently so that they can feel success and achievement.

Include the student in all sessions as the rest of the group. Get them to be as involved in the activity as much as they can.

We were struck by the frequency of the advice concerning support for inclusion. Research (Cologon, 2014b; Department of Education Science and Training, 2006) suggested that initially teachers seek syndrome specific strategy advice. However, Forlin and Chambers (2011) indicated that “there is also a growing body of research that has identified positive attitudes as being equally important as, if not more important than, knowledge and skills as prerequisites for good inclusive teachers” (2011, p. 18).

The comments from the members of teaching teams indicate that their experiences and associated support have given them a confidence that including

children with Down syndrome in primary mathematics classrooms is an achievable goal.

Table 1

Categories and frequency of responses to question - What advice would you give others who are including a child with Down syndrome in mathematics classrooms?

Response category	Frequency
Explicit encouragement to emphasise inclusion in mathematics	11
Providing concrete/visual and related materials generally additional to regular mathematics classroom needs	7
Importance of relationships and collaboration within the team including the parents	7
Be prepared to repeat as needed or find smaller steps to support mathematics learning	4
Sharing with others including school visits and professional development sessions	2
Ensure engagement including making mathematics fun and interesting	2
Be prepared to give extra support	1
Don't panic	1

Note: More than one category was evident in some responses

The following quote is representative of the important components of support identified by the participants:

Attend PDs related to mathematics for reluctant learners; work collaboratively with the child's teacher aide. Perhaps visit other schools with children with DS. Plan effective maths lessons that cater for all children's needs. Be well resourced.

Conclusions and Implications

Our topics for inclusion in the initial professional learning that we extracted from the literature were judged worthwhile by the teachers and included: a shared understanding of inclusive practice; an understanding of Down syndrome; and effective use of resources in mathematics education, including calculators. They also identified the need for a greater emphasis on improving their own knowledge related to the mathematics learning of children with Down syndrome. Advice suggested for teachers preparing to teach in such settings was overwhelmingly positive in relation to the value of inclusive mathematics teaching.

It is important to acknowledge the complexities of teaching in this environment and the need for a range of support. As responses of the teachers and aides indicate it is difficult to predict what the behaviour of the children will be, what they know and how they will respond to mathematics lessons on any particular day. Indeed, identifying ways to circumvent behaviours that are detrimental to learning remain a challenge for research. Having said that, we were encouraged by the creative ways that teachers engaged in both the teaching and the sharing of their developing expertise, and as we continue analysing our data we hope to provide greater insights into mathematics teachers and teaching in these inclusive classrooms.

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