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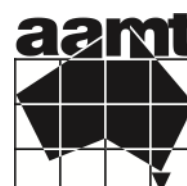
Title of chapter/article	Teaching children with Down syndrome in inclusive primary mathematics classrooms
Author(s)	Rhonda Faragher, Melanie Stratford & Barbara Clarke
Copyright owner	The Australian Association of Mathematics Teachers Inc.
Published in	Australian Primary Mathematics Classroom vol. 22 no. 4
Year of publication	2017
Page range	13–16
ISBN/ISSN	1326-0286

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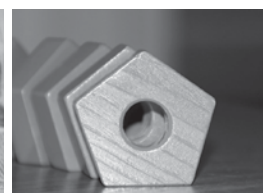
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APMC



Volume 22 Number 4 2017



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ISSN 1326-0286

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Teaching children with Down syndrome in inclusive primary mathematics classrooms



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Planning mathematics lessons for a class that includes a student with Down syndrome is challenging. This article explains how removing the onus of number work allows the student to demonstrate understanding of other areas of mathematics.

Introduction

At the turn of this century, expectations for learning mathematics by students with Down syndrome were low. Research and practice continued to indicate considerable difficulty with number and calculation (Bird & Buckley, 2001). Unfortunately, most authors extrapolated difficulty with number to difficulty with mathematics in general, even though research evidence from other areas of mathematics was almost non-existent.

We now know that mathematics beyond calculation is within the grasp of learners with Down syndrome (Faragher & Clarke, 2014). In this article, based on findings from a research study that was undertaken in the ACT and Victoria, we describe how learning mathematics in inclusive primary classrooms can be achieved.

Teaching teams (classroom teachers and learning support staff) worked with researchers to explore effective inclusive mathematics teaching and here we give researcher and practitioner perspectives on how this might be accomplished through explicitly adjusting the curriculum for a Year 6 class.

An inclusion story

To give an indication of the work of teachers in inclusive mathematics classrooms where there is a student with Down syndrome, one of the teachers who participated in the study describes her work from her perspective. She was the teacher of a Year 6 class. We will use this vignette to raise points we believe to be important for planning inclusive mathematics learning.



Planning for learning

All learning opportunities were embedded within the framework of the Year 6 Mathematics Curriculum even though Emily's mathematical understanding was significantly lower than that of her peers. Planning for learning involved making adjustments that fostered Emily's inclusion in all aspects of the mathematics lesson. Some examples of how the curriculum was adjusted included the provision of tools such as an iPad with specific applications, modification of tasks, adjustments to whole class activities to include hands-on materials for all students, and the involvement of a LSA (learning support assistant) in most mathematics lessons.

Working with the team

Lesson objectives were shared with LSAs prior to each lesson in a brief conversation (see Figure 1). Shared planning time is not possible but it is important to ensure the LSAs are aware of the mathematical purpose of the lesson and the adjustments planned for Emily. The LSA was present in most mathematics lessons and was typically engaged working with small groups which included, but were not limited to, groups that included Emily. This classroom support also enabled me to provide support to Emily as required.



Figure 1. Sharing lesson objectives.

A lesson in action

The Year 6 class was learning to multiply and divide decimal numbers over a series of lessons. The observed lesson began by displaying on the board, problems to solve with the students having their own copy of the task in front of them. Emily was provided with an enlarged copy of the activity. The teaching of the whole class sitting at their own desks involved modelling strategies to multiply

and divide decimal numbers. There was a focus on thinking, using 'think alouds' where I modelled strategies for thinking through problems.

After the modelled phase of the lesson, the students were divided into heterogeneous groups to solve more exercises involving the calculation of division with decimal numbers. Both the teacher and LSA moved between groups to assist as required.

The next phase of the lesson involved the students working independently to solve the same types of exercises previously modelled and solved in the small groups. As needed, Emily used a Talking Calculator application on her iPad.

The final phase of the lesson involved reflection on the strategies used. Emily was included in these conversations.

The calculator app was actively sourced because the standard classroom calculator was proving difficult for Emily. The large format of the buttons and audible feedback featured in the app supported her to independently calculate. Emily used the app in the lesson and this allowed her to complete the exercises. She was able to accurately determine the operation needed each time. She was particularly careful with the position of the decimal point, both in entering on the calculator and recording and interpreting the result.

We will now use this example to discuss points of importance in inclusive mathematics education practice.

Adjusting the curriculum

When including a student with Down syndrome in the regular mathematics program, challenges can immediately arise, particularly in the later primary years where the gap between the student's achievement and that of the class can become large.

Number work appears to be particularly difficult for learners with Down syndrome and relatively more difficult than other areas of mathematics (Fragher, 2017; Fragher & Clarke, 2014) for these students. However, explicitly teaching the use of a calculator can allow successful learning of other areas of mathematics (Monari, Martinez & Pellegrini, 2010). In this approach, the calculator acts as a prosthetic device (Horton, Lovitt, & White, 1992), that is, it supports the body to do what it cannot, allowing access to other mathematics.

The use of a calculator makes possible an alternative approach to the once standard approach of assessing a learner and teaching from their developmental stage. The alternative approach is called ‘year level appropriate curriculum’ (YLAC), sometimes also known as ‘age appropriate curriculum’. The approach of YLAC aligns with the *Australian Curriculum* which specifies a year level curriculum. The steps involved in the process of planning within a YLAC approach for learners with Down syndrome (or students with any other mathematics learning difficulty) are listed in Table 1 and explained in the following sections.

Table 1. Steps in curriculum adjustment.

1	Start with the curriculum for the enrolled year level of the student.
2	Seek guidance about specific learning issues.
3	Explicitly plan adjustments, including the work of LSA.
4	Provide opportunities for consolidation and practice.
5	Assess learners throughout the learning process (not just at the end).

1. Start with the curriculum for the enrolled year level of the student

Beginning with the curriculum document or program applicable to the year level of the class, the teacher prepares unit and lesson plans. This involves methods for making the material accessible to all learners in the class, including those needing extension. This is the standard planning process undertaken by teachers.

2. Seek guidance about specific learning issues

Specialist learning support information can be accessed about the effect of a disability on the learning of mathematics. This advice may be external to the school such as through Down Syndrome Associations. School-based teams may include other teachers of the year level, learning support coordinators, and in many situations, LSAs.

3. Explicitly plan adjustments, including the work of LSA

This involves considering challenges likely to be faced by the student and planning to overcome them. Students with Down syndrome are known to benefit from visual support. This does not mean only pictures or symbols but can also be printed text (words) and written mathematics, such as equations and diagrams. Calculators are

key tools for a learner with Down syndrome. From the assumption that calculation will be taken care of, teachers can look at the mathematics content of their unit and lessons.

Classroom teachers remain responsible for the learning of all the students in their class and effective use of LSAs involves ensuring they are aware of the mathematical purpose of lessons and their role in supporting learners in the class.

4. Provide opportunities for consolidation and practice

A key aspect of planning is the provision of opportunities for consolidation and practice of mathematical concepts. This is critical for those who find learning difficult and for whom learning may be unstable. The ‘little bit, often’ rule, so powerfully used by advertising, is particularly effective. Many teachers use the beginning of mathematics sessions for revision of these concepts on a regular cycle.

5. Assess learners throughout the learning process

Mathematics is often assessed at the completion of a unit of work, such as with tests or examinations. Learners with Down syndrome are known to perform erratically on tests, including formal psychological testing (Wishart & Duffy, 1990). Understanding question words has recently been identified as a significant source of difficulty (Morgan, Moni, & Jobling, 2009), even by articulate students who have a relative strength in language. These issues emphasise the need for teachers to gather evidence of learning throughout the unit of work and perhaps in innovative ways. The ready availability of cameras—still and video—and other electronic options simplify this process for teachers. Teachers should be assured that these forms of evidence of learning are at least as valid as traditional approaches such as written tests.

The role of the calculator

The lesson described by Melanie Stratford had a focus on calculation with decimals. In a broader sense, it was concerned with the development of place value. Through the use of the Talking Calculator, Emily was able to accurately and independently calculate large and decimal numbers involving all four operations. Melanie noted that the student consistently attended to the importance of the decimal place and was able to identify the correct operation required. This is an important observation. While Emily has difficulty

with performing calculations and requires a calculator for this purpose, she is able to understand the underlying concept of the use of the decimal symbol. She is also able to select the required operation indicating her understanding of what mathematics is needed to be done, even though she needs the calculator to perform the task.

Using research to raise expectations

In our study, we have been investigating how inclusive practice might be accomplished for learners with Down syndrome in primary mathematics classrooms. In the inclusion story presented in this paper, an example is provided of how a teacher implemented lesson adjustments to include a learner with Down syndrome in a Year 6 mathematics lesson, even though the student's mathematics accomplishments were many years below that level. With the support of technology, the student was able to receive assistance with the calculation she could not do in order to engage with the concepts of the mathematics lesson—working with decimal numbers.

What we have learned so far

Our work proceeds from a very low base of societal expectations of what was thought to be possible for mathematics education of learners with Down syndrome. By documenting the practice of effective teachers working in inclusive primary classrooms, it is clear that students with Down syndrome can learn important mathematics alongside their peers without disability. We have also learned that this is very rewarding work, indeed.

Acknowledgements

The research project is funded by Gandel Philanthropy and undertaken in conjunction with the Australian Council for Educational Research Foundation. The authors acknowledge the invaluable contribution of teachers, teacher assistants and the students to this research.

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