

# Targeting the 'big ideas' in Mathematics

LONG READS

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Differentiating instruction to better meet the needs of all learners is not new. It recognises that in any classroom there are significant differences between students in terms of their prior knowledge, experience, preferred ways of learning and their social and emotional predispositions to learn.

*'Educational researchers have known for decades that a student learns best when teaching is targeted to what she is ready to learn. If the material is too easy, students can become bored and disengage. If it is too hard, students will flounder and may choose to misbehave or give up rather than face continued failure. In either case, little is learnt. But if teaching is targeted at what students are ready to learn, powerful progress can be made.'* (Goss, Hunter, Romanes & Parsonage, 2015)

## Requirements of targeted teaching

From my perspective, targeted teaching is a form of differentiation that is specifically concerned with student's learning needs in relation to several 'big ideas' in number, without which their progress in school mathematics will be seriously impacted. It requires:

- assessment tools and techniques that expose students' thinking and provide valid and reliable information about where students are 'at' in relation to an important big idea;
- a grounded knowledge of underlying learning progressions, key steps in the development and application of big ideas and how to scaffold these;
- an interpretation of what different student responses might mean and some practical ideas to address and progress student learning (i.e., where to go to next);
- an expanded repertoire of teaching approaches that accommodates and nurtures discourse, helps uncover and explore student ideas, and ensures all students can participate in and contribute to the enterprise;
- time with students to develop trust and supportive relationships; and
- the flexibility to spend time with the students who need it the most (Siemon, Virgona & Corneille, 2001).

This notion of targeted teaching was prompted by the findings of two large-scale projects that revealed a seven to eight year range in mathematics achievement in each year level in the middle years of schooling (Siemon, Virgona & Corneille, 2001) that was explained by student's access to multiplicative thinking (Siemon, Breed, Dole, Izard & Virgona, 2006).

Multiplicative thinking is the conceptual and strategic knowledge needed to work efficiently and confidently with larger whole numbers, fractions, decimals and percent and to solve an extended range of problems involving multiplication and division including proportional reasoning. Access to this kind of thinking is needed to successfully engage with school mathematics beyond Year 5 and realistically aspire to further STEM-related studies.

Data from the Scaffolding Numeracy in the Middle Years (SNMY) project, the second of the two studies mentioned above, found that approximately 70 per cent of Year 5 and 35 per cent

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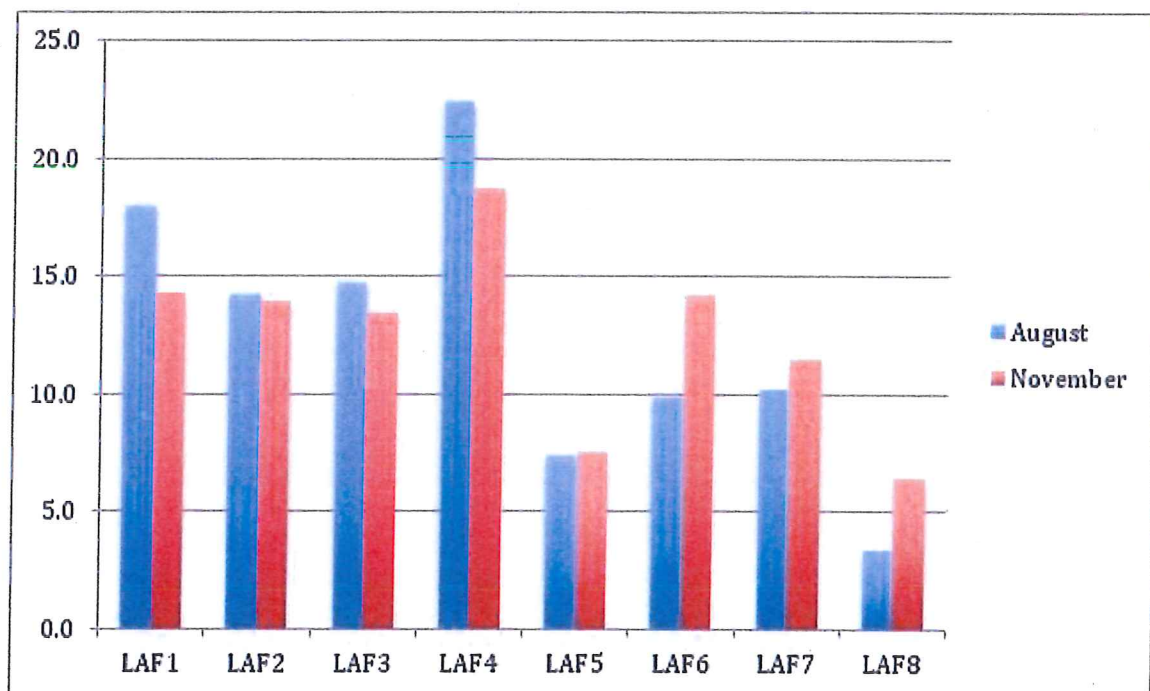
of Year 8 students did not have access to multiplicative thinking. A 2014 study that used the same tools to assess multiplicative thinking in over 1700 Year 7-9 students from lower socio-economic schools found that the proportion for Year 8 students was closer to 55 per cent (Siemon, Milne, Sharpley & Vanderpal, 2014).

### Targeted teaching to big ideas works

Analysis of the SNMY data led to the identification of an eight-level [Learning and Assessment Framework for Multiplicative Thinking \(LAF\)](#). Teaching advice was prepared for each level (referred to as 'zones') to help teachers consolidate the knowledge and skills identified at that zone and scaffold what was needed for students to progress to the next zone in the framework.

Teaching targeted to students' identified learning needs in relation to the LAF resulted in effect sizes of 0.45 to 0.75 or more in research schools, compared to effect sizes of 0.2 to 0.5 in reference schools. Breed's (2011) 18 week intervention, conducted as part of the SNMY project, involved nine Year 6 students identified in Zone 1 of the LAF. When re-assessed three months after the intervention, all nine students shifted at least four zones, with the majority shifting five zones to be age and grade appropriate.

In 2013, SNMY data was obtained from 28 schools located in lower-socio economic settings in the Northern Territory, Queensland, South Australia, Tasmania and Victoria. Matched data sets were obtained from 1732 students from Years 7-10 with the majority (59 per cent) from Year 8. Although the results varied considerably between schools, the overall achievement of students across the 28 schools represents an average effect size of 0.6, which can be seen the shift in the relative proportions in each zone of the LAF from August to November shown in Figure 1.



[Figure 1: Proportion of students by LAF zone in August and November 2013.]

### Targeted teaching F-10

While the SNMY assessment options and teaching advice can be used with students from Years 4-9, something more is needed to help prevent, or at least substantially reduce, the seven to eight year range in mathematics achievement in the middle years. As a result of unpacking the zones, I identified six 'big ideas' in number that need to be in place by the end of key levels of schooling to ensure students are ready to learn what is needed to progress confidently in school mathematics. Not surprisingly, most relate in some way to the development of multiplicative thinking.

By the end of	Big Idea
Foundation/ mid Year 1	<b>Trusting the Count:</b> students believe that if they count the same collection again they will get the same amount; they can draw on mental objects for each of the numbers to ten based on visual imagery that allow them to 'see' these numbers in terms of their parts and as they relate to numbers of which they are a part (e.g., 8 is 6 and 2, double 4, 2 less than 10).
Year 2	<b>Place Value</b> (a multiplicative structure): students see 10 ones as 1 ten and are able to work fluently with counts of tens and counts of ones independently; they understand and can use the relationship that 10 of these is 1 of those to extend the whole number system to hundreds and beyond.
Year 4	<b>Multiplicative Thinking</b> (initial ideas): students move beyond an understanding of multiplication and division as repeated addition; they have access to efficient strategies for multiplication and division based on the number of groups rather than the number in each group (e.g., 3 of anything is double it and one more group).
Year 6/end of primary school	<b>Partitioning</b> (another aspect of multiplicative thinking): students extend their ideas about multiplication and division to make connections to fractions, decimals and per cent; they understand and use the 'for each' idea to solve simple proportional reasoning problems.
Year 8	<b>Proportional Reasoning</b> (a key defining aspect of multiplicative thinking): students recognise and work with relationships between numerical quantities; they represent these in multiple ways (e.g., graphs, tables, expressions) and solve problems involving fractions, decimals, per cent, rate, ratio and proportion.
Year 10	<b>Generalising:</b> students recognise, describe and represent patterns, relations and functions in multiple ways; they work confidently with algebraic expressions and relationships to solve an extended range of problems.

[Table 1: The big ideas in Number by key levels of schooling (Siemon, 2006).]

A suite of performance-based, one-on-one interview tasks were developed to evaluate key aspects of each of these big ideas. These are supported by a range of student responses to each task, an interpretation of what each response means and specific teaching advice to assist teachers recognise and build on what the student already knows and can do. Known as the [Assessment for Common Misunderstandings](#), these resources are now being used to support targeted teaching and improve mathematics learning outcomes in primary schools in the Australian Capital Territory, Queensland, South Australia, Tasmania and Victoria.

### Some final thoughts

In conclusion, targeted teaching is characterised by an unrelenting focus on ‘big ideas’, without which students’ progress in mathematics will be seriously impacted.

It takes time and effort. Our experience to date has shown this to be a very organic process that schools appropriate and implement according to their circumstances. Targeted teaching is most effective where it has evolved over time with the support of key individuals and the leadership group and the provision of targeted professional learning.

### References

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How are you monitoring individual student progress?

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How do you know when students are confident in their learning and ready to move on to the next steps?

As a school leader, what whole school intervention strategies are you implementing to identify and support students who are falling behind in mathematics?