Mathematics teachers: Dealing with difference


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Teachers face many challenges when catering for the diversity in their classrooms. One way that schools sometimes try to overcome these challenges is by grouping students according to ability. Is this a solution to the problem?

A major problem for teachers is that students are different, they learn mathematics differently, and at different rates. Regardless of this, in schools we organise students into large groups or classes of 20 to 30 students all about the same age. Then there is the *Australian Curriculum: Mathematics* that states the student learning outcomes that are expected for students at each Year level of school - which means at each year of their lives. Teachers are expected to teach the curriculum prescribed for students of the specific age group in their class and still keep in consideration student differences. How does a teacher of primary mathematics deal with the range of student thinking and knowledge in his or her class every day? With difficulty, we hear you say. That is true. Catering for student difference is a substantial challenge for teachers.

There is a view by some policy-makers, school leaders and teachers, that management of students in ability groups in classrooms helps to deal with the range of mathematical knowledge and improves learning outcomes. Unfortunately, the research evidence over a long period of time shows this is not the case and that ability grouping in mathematics leads to a decline in learning standards overall (Boaler, 2014). The weight of evidence from countries across the world indicates that ability grouping harms the achievement of students in low and middle groups and does not affect the achievement of high attaining students (Boaler, 2014). Globally, the countries that have the most successful results in terms of international achievement are those who do not use ability grouping practices (Anthony & Hunter, 2017; Boaler, 2014).

Despite evidence to the contrary it seems that ability grouping in mathematics is widespread. In some schools, teachers test the students in their classes and divide them into teaching groups according to their results on the tests. In other schools the students are tested and divided into Year level achievement-based classes.

Theoretically, these processes put students into like-ability groups. In fact, the groups are still mixed-ability groups, although each group may have a narrower range of student mathematical knowledge about the topic tested.

The actual term ability is in common use in education and usually goes unquestioned (Marks, 2014). There are two issues about the use of ability groups that seem to be problematic: the name, and the assumption that grouped students are then alike. The consequences of referring to the clusters of students who achieve similar test results as of similar ability is unfortunate to say the least. Synonyms for ability are capability, skill, talent, capacity, gift, and knack. Of these words, perhaps skill is the only one that is being measured by a classroom mathematics test.

In addition, "ability" brings with it a fixed mindset. The metaphor of mindsets was described by Dweck (2000) who categorised students' orientation to learning. She described mindset in terms of whether students hold either mastery goals or performance goals. A fixed mindset, in which students think they are as smart as they are ever going to get, is connected to performance goals. Students with a fixed mindset believe they are as intelligent as they will ever get and they; seek success but mainly on tasks with which they are familiar; avoid or give up quickly on challenging tasks; and derive their perception of ability from their capacity to attract recognition.

In contrast, students with mastery goals pursue understanding of the content, and evaluate their success by whether they feel they can use and transfer their knowledge. Students with a growth mindset believe they can get smarter by trying hard and this is connected to mastery goals. Such students: tend to have a resilient response to failure; remain focused on mastering skills and knowledge even when challenged; do not see failure as an indictment on themselves;

and believe that effort leads to success (Dweck, 2000). It seems imperative that we encourage a growth mindset in our students.

The construction of ability groups by teachers may promote performance goals and a fixed mindset. However, we think that most teachers believe that ability grouping is in the best interests of their students. Their belief seems to be based on their thought that constructing ability groups enables them to target students' learning needs with different mathematical tasks.

The assumption that, in each constructed group, the students are alike in their mathematical knowledge and thinking based on a single short test is questionable. While the range of knowledge of the topic tested may be truncated in each group, the students are still different. The danger is that the teacher who has students with the same test scores treats the students as the same in terms of their thinking. Possibly the groups are labelled by the teacher's characterisation of them as well. We have heard teachers privately refer to a group as the "lower group" and the "top group". We know that students live up to—or down to—teachers' expectations of them. There is widespread acceptance that teachers' expectations are important for student learning (Rubie-Davies, 2009). By dividing students into groups and thinking of them according to their "ability" teachers are, often unwittingly, giving messages about their expectations to their students through their interactions (Cooper & Brophy, 1983; Marks, 2014; Nunes et al., 2009).

A serious consequence of grouping the under-achieving students is that they are then given different mathematics—often simpler exercises requiring fewer steps in reasoning and devoid of problem solving contexts. Teachers can often simplify the mathematics, encourage rote-learnt processes, where little understanding is required (Clarke & Clarke, 2008; Marks, 2014). These practises, we would argue, systematically impoverish students mathematically. In addition to being offered a watered-down curriculum these students do not have the opportunity to hear the mathematical reasoning of other students whose mathematical approaches may offer them new ways of thinking through problems. Sullivan and his colleagues (2014) argued that "classrooms in which students act as a community are more likely to support the learning of all students" (p. 127). This view emphasises the social process of learning mathematics where students engage in discussion around the same content, justify and share their strategies, establish connections and extend the contributions of others.

The danger of dividing the students into "like groups" is that they are then treated as a group instead of as individuals. For teachers, working with four groups of seven students seems a more manageable task than teaching 28 individuals. You can see the appeal of grouping as a management technique if you are convinced that it is effective. However, research findings show "that most students are disadvantaged by classes grouped according to ability" (Clarke & Clarke, 2008, p. 31). It is a practice that results in a hierarchy of competence based on a fixed mindset and gives inequitable access to mathematical learning (Boaler, 2014; Marks, 2014). We would doubt that most primary classroom teachers would be aware that their well-intentioned grouping of students disadvantages the very students about whom they are most concerned.

Without minimising the problem of the range of mathematical thinking in classrooms, we would like to consider an approach that is not a management solution but a pedagogical one. Our first suggestion is to use mixed-ability approaches to teaching as they have consistently demonstrated more equitable outcomes than ability grouping (Boaler 2008, 2005, 2014; Cohen & Lotan 1997; Linchevski & Kutscher 1998).

We also suggest that broadening the types of mathematical tasks (Sullivan, Clarke & Clarke, 2013) offered to students can help address the range of student thinking. By incorporating challenging problems, investigations, mathematical games and open-ended tasks to any mathematics program teachers can address some of the differences in student thinking in their classrooms and potentially extend all students (Cheeseman & Montgomery, 2000; Siegler, 2010; Sullivan et al., 2014). Recent literature suggests that "changes towards more flexible heterogeneous grouping practices aligned with collaborative problem-solving learning environments will better support equitable and productive learning opportunities." (Anthony & Hunter, 2017, p. 73).

Problem solving tasks have features that enable students to engage in mathematics in their own ways. Posing open problems and preparing prompts can vary the task so that children who need support on that particular problem can complete the task and those who solve the problem quickly can be further challenged. This pedagogical technique allows tasks to be differentiated in the moment in response to what teachers notice as the students' needs for support and extension. "Enabling" and "extending" prompts (Mousley, Sullivan & Zevenbergen, 2004) vary the original task and may include strategies such as: adjusting the size of the numbers, reducing the number of steps, or representation of the problem. An example is shown in Table 1. Most importantly though, these prompts allow all students to engage with the same problem and engage in the discussion and review of the task. This approach is in contrast to the approach in ability groups where students in different groups, pursue different learning goals and possibly even focused on different mathematical content where a conclusion of the lesson that elicits the central mathematical concepts is not feasible.

Table 1: Learning task with an enabling and extending prompt.

Open task for investigation	Enabling prompt	Extending prompt
When Josie was counting out loud from 0 to 50 by a number other than 1, one of the numbers she said was '48'. What number might she have been counting by?	When Josie was counting out loud from 0 to 25 by a number other than 1, one of the numbers she said was '24'. What number might she have been counting by?	When Josie was counting out loud from 0 to 100 by a number other than 1, one of the numbers she said was '96'. What number might she have been counting by?

We believe that all students can learn mathematics and should have the opportunity to do so. The research is clear, the single most important factor in a student's learning is his or her teacher (Askew & Brown, 2003). Therefore, it is the responsibility of the teacher to provide challenging and engaging learning opportunities for students while they are at school. Merely placing students in groups or not grouping students, does not seem to be enough to promote substantial gains in achievement. It is how students collaborate in groups, what the teacher values, says, does and how the students respond that is most important (Anthony & Hunter, 2017; McDonough, 2003). There appears to be no substitute for effective teaching and quality teachers.

Conclusion

As Clarke and Clarke (2008) acknowledged "catering for the wide range of levels of confidence and competence in mathematical understanding is possibly the greatest challenge which teachers face" (p. 32). However, dealing with this challenge by ability grouping students in mathematics classrooms is not the answer. It is disappointing to note that despite Clarke and Clarke's compelling case arguing, for nine main reasons of effectiveness and social justice, that the time for ability grouping was up, we are still arguing against its use a decade later. The pedagogical strategies that were suggested to teachers at the time are echoed in those recommended here for use in primary schools. Perhaps the first and most telling step is to convince teachers that ability grouping of students in mathematics is likely to do more harm than good. It is a practice focused on performance goals and, based on test results, and suggests to students that they are as smart as they are going to get. The next step in to integrate productive and inclusive pedagogies into the everyday teaching and learning of mathematics.

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