Mathematics assessment in primary classrooms: Making it count

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Abstract

Much has been written about assessment *of* learning, assessment *for* learning and assessment *as* learning. These three conceptions of assessment are examined in relation to primary mathematics. Drawing on research from Australia and overseas, effective practices in mathematics assessment in the primary classroom are identified and the implications for teaching and learning considered.

Introduction

Assessment practice has been an ongoing focus of educational research for over a quarter of a century. In that time new tools have been developed and the curriculum focus has shifted to the outcomes of the learning process (Black & Wiliam, 2003). The promise of raising students' learning outcomes through targeted assessment stimulated Australian and other education systems to introduce large-scale and costly assessment programs such as NAPLAN, as part of a 'pressure and support' approach to educational reform (Fullan, 2000). Despite this activity, the promise of improved outcomes from changed assessment practices has not been achieved on a large scale (Stiggins, 2007).

In this paper, aspects of quality assessment practice in primary mathematics are explored, based on local and international research. Assessment is regarded as more than the task or method used to collect data about students. It includes the process of drawing inferences from the data collected and acting upon those judgements in effective ways. Such actions may occur at many levels, but the key focus considered here is the school and, particularly, the classroom. The assessment focus may be summative in nature providing a snapshot in time of mathematical competence or achievement. Alternatively, it may be formative and used to change teaching and learning approaches.

Consider this scenario observed in a Tasmanian primary school:

> The teachers are meeting in grade teams. They are sharing the 'big books' about mathematics that the children in their class have produced. The discussion centres on what the books demonstrate about the children's understanding, and what the teachers need to do to move that forward. In the discussion, teachers compare the work samples and make judgements about their own and other teachers' students. They refer frequently to the state curriculum documents, NAPLAN results, the school policies and 'throughlines' that have been developed collaboratively to ensure a common language and focus across the school. These throughlines, along with specific strategies for computation, are prominent in every classroom. By the end of the meeting, all teachers have a commitment to some action for their class, and to increase the school focus on specific aspects of mathematics at which the students appeared to do less well on the NAPLAN. This school is in a middle-lower socio-economic range and is one of the most successful in the state on NAPLAN numeracy, particularly when value-added measures are considered.

The picture painted above is of a real school in which mathematics assessment is used productively. The teachers were using a complex mix of assessment information to develop teaching plans. NAPLAN data was discussed to identify where, as a school, there were identified strengths and weaknesses. This use of NAPLAN

assessment data provided a formative function at a school level. The work that students had produced in their classrooms was being used both formatively and summatively. Teachers referred to the curriculum standards to make judgements about their students' progression and understanding, moderating their decisions against work samples from other teachers' classrooms through deep professional discussion. These conversations supported teachers in making choices for their own classrooms.

The classroom is the powerhouse of learning. Teachers make a difference (Hattie, 2009) and efforts to improve students' learning outcomes must focus on teacher practice. It is impossible, however, to talk about assessment divorced from pedagogy. The approach that the teacher uses underpins the quality and nature of learning in the classroom (Wiliam & Thompson, 2007). Such approaches include the use of assessment for learning – identifying a student's 'readiness to learn' (Griffin, 2000) so that planned learning experiences are maximally effective. The notion of assessment *for* learning implies that teachers will not only be able to identify what students can do, but also what activities and learning experiences need to be planned to develop students' thinking.

Assessment *for* learning

What does this look like in practice? First a task is needed that addresses the desired mathematical concept and also provides for a wide range of different levels of understanding. Teachers then predict likely responses, and maybe group these into categories of similar understanding. The final action, and this is the key, is to develop strategies for extension for each level of understanding. The first of these actions, providing a task, is relatively easy. There is an abundance of quality material available to teachers – the difficulty is choosing what to use. The second, predicting likely responses, is also one that teachers can do relatively well, and is now supported by a plethora of work samples and examples from publishers, education systems and professional bodies. Identifying what to do next, however, is difficult (Wiliam, 2000a).

Recent work on identifying and measuring teachers' mathematical pedagogical content knowledge, however, indicates that although primary teachers can recognise and predict students' responses to questions, both correct and incorrect ones, they have considerable difficulty in identifying the next steps to take to develop students' understanding (Watson, Callingham, & Donne, 2008a, 2008b).

For example, one primary teacher participating in a study relating to developing students' statistical understanding in response to a question showing information about market share among large supermarkets using a pie graph that added up to more than 100 per cent, suggested that students might respond in the following ways:

> *What percentage of the retail market Coles has. *Some might notice (a) that it doesn't add up to 100%, *(b) 61% should be more than half the graph, *(c) the whole graph is inaccurate (not measured using a protractor etc.)

In her response to the follow-up question, 'How would/could you use this item in the classroom? For example, how would you intervene to address the inappropriate responses?', the same teacher answered 'As a critical literacy/ maths activity'. Although this teacher demonstrated a depth of understanding of the mathematics involved, and about what her Year 6 students might do, she was unable or unwilling to suggest any real follow-up activity.

Assessment *as* learning

If teachers find it difficult to articulate meaningful activities that would move their students forward, what does this suggest about assessment *as* learning, that is assessment completely indistinguishable from the learning activity? Such assessment is informal, undertaken as part of the teacher's 'normal' activity. It often involves a teacher recognising a 'teachable moment' and acting on this. For example, in a Korean kindergarten class children were using blocks to explore the number nine by putting them into groups of five and four. One girl had taken ten blocks and had organised these into two groups of five. The teacher noticed this and set up the next task to rearrange the blocks into groups of six and three. This next step provided the child with the chance to self-correct, and she put the extra block back into the container. Clearly the teacher made an assessment of the child and gave an immediate response that provided feedback to her in a way that changed her actions. It seems that this kind of teaching activity meets the requirements indicated by Black and Wiliam (1998) for effective feedback.

Classroom assessment, both assessment *for* and *as* learning, relies on dialogue between the child and the teacher (Callingham, 2008). Primary teachers know this and when asked about what they would do with their students often reply in terms of the questions they would pose or the discussions they would have. Teachers in the statistics study were asked, for example, how they would respond to a child who had read a pictograph about how children came to school and had given the incorrect response 'Bike, because the majority of boys ride to school'. A typical response was this one from a South Australian primary teacher:

> That's interesting isn't it? I would be asking what his reasoning

behind that would be and obviously he would say, well they're all boys and Tom's a boy, therefore he will come to school because that's where most of the boys come along. And I would discuss with that child, and talk about his reasoning why he discounted the bus, car, walking and train. What was the reasoning behind you discounting the fact that he couldn't come by bus, car, walk or train? And that would be how I would move him forward.

Teachers perceive this kind of activity as the process of teaching, rather than feedback from assessment, and this perception has implications for professional learning (Callingham, Pegg & Wright, 2009).

Assessment *of* learning

So far there has been little in this discussion about the place of summative assessment: assessment *of* learning. In recent years it seems that teachers have rejected the notion of summative assessment. Biggs (1998), however, argued that it has an important place in classroom assessment, and should be seen as part of a comprehensive assessment plan. He advocated, for example, using graded portfolios as an 'information-rich' form of summative assessment and suggested that whether an assessment was summative or formative was largely a matter of timing. Assessment of learning does not have to be test-based, and work samples that demonstrate a student's mathematical understanding are affirming and powerful demonstrations to the child, and others, of what he or she has learned. The two work samples shown in Figure 1, for example, demonstrate two kindergarten students' attempts to copy a pattern. The child who produced the top example appears to understand that the design has to run across the page, but doesn't pay attention to the order of the symbols. The bottom example, however, orders the symbols but appears to be reading the pattern from right to left, making a mistake as the pattern runs onto a second line. If these samples were collected at the end of a teaching sequence, they perform a summative function, providing a record at one point in time of what a child can do. In contrast, collected during a teaching sequence, the same task could provide formative information helping to inform the teacher's planning.

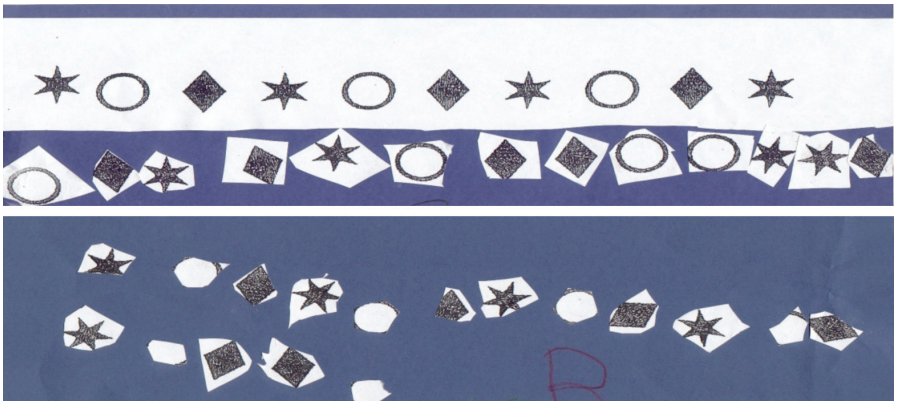

Figure 1: Kindergarten children's attempts at copying a pattern

Assessment in the primary mathematics classroom: Making it count

Assessment is arguably the most powerful element in teaching and learning. Quality assessment can provide information to students, teachers, parents and systems in effective and useful ways. To be helpful, however, it must be broad ranging, collecting a variety of information using a range of tasks before, during and after a teaching sequence.

To make assessment count, the focus of professional learning for primary mathematics teachers might need to shift. Rather than developing teachers' mathematical content knowledge, changing pedagogical approaches through rich mathematical tasks, or applying models such as the NSW Quality Teaching model, more productive professional learning might be focused on addressing students' specific, identified learning needs, using the many work samples now available and asking the question 'where to now'?

Mathematics learning is idiosyncratic – no two children learn mathematics in the same way. It is also non-linear – proceeding in jumps as a group of ideas coalesce into a new cognitive framework. Assessment needs to accommodate these variations so that feedback to students can directly change what they do, such as the subtle feedback given by the Korean teacher described earlier. Educating teachers about effective feedback, however, may be more efficacious within a pedagogical perspective than one that is directed at assessment.

Perhaps the time has come to stop worrying about the nature of the assessment activity, its summative or formative purpose and the political ends for which the information may, or may not, be used. Instead, all educators need to get 'back to basics' and remember that it is quality teachers, making rapid professional judgements on the run in busy classrooms that create the 'meanings and consequences' (Wiliam, 2000b) that affect children's

interest and involvement in matters mathematical.

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