0679

Implementing formative assessment in the context of algebra

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Background

There is good evidence to suggest the efficacy of an approach based on formative assessment and feedback (Black & Wiliam, 1998; Hattie & Timperley, 2007). In England, over the past decade formative assessment has been phenomenally "successful" with both policy-makers and the teaching profession. Much of this influence is due to a developmental research project conducted partly in secondary mathematics (Black et al, 2003). Yet, evidence suggests that teachers and schools have considerable difficulties in implementing the approach (e.g., Smith & Gorard, 2005), particularly in mathematics (PricewaterhouseCoopers, 2008). There are several reasons for these difficulties. First, although much of the evidence relating to the efficacy of formative assessment is situated in mathematics education contexts, to date, descriptions of the approach have largely focused on a generic pedagogy rather than on subject-specific didactics. Teachers' ability to use formative assessment and feedback in mathematics is limited by their knowledge about key mathematical ideas, the likely difficulties that students will face, and appropriate pedagogic strategies. Thus, if teachers focus on teaching mathematical procedures, they may find it difficult to see the causes of problems for students in mastering and applying these, and though aware of the importance of particular generic formative assessment strategies (e.g. questioning or facilitating dialogue), they may not know how to implement these strategies mathematically nor how to tailor them to the particular learning needs of their students (Hodgen, 2007; Watson, 2006). Current textbooks in England accentuate the problem by presenting school mathematics as fragmentary and lacking coherence (Haggarty and Pepin, 2001). Second, interventions associated with formative assessment have underestimated the structural obstacles to pedagogical innovation within classrooms (Ruthven, 2009). This is not helped by a misinterpretation at a policy level of formative assessment as summative assessment in initiatives such as Assessing Pupil Progress (Black, 2009).

Research Questions

This paper will address the issue of how formative assessment can be implemented in mathematics education by examining the special case of algebra.

Methods

The approach has been developed collaboratively with a group of eight teachers using a design research methodology (e.g., Cobb et al, 2003). The paper will draw on analysis of semi-structured interviews with the teachers and evidence from classroom trials.

Frame

The paper will examine an approach to overcoming these difficulties using a series of research-based lessons in algebra that are being developed by the Increasing Competence and Confidence in Algebra and Multiplicative Structures (ICCAMS) project. The approach is informed by research on children's methods (e.g., Plunkett, 1979; Hart, 1981; Küchemann, 1981), on previous teaching experiments involving diagnostic assessment (e.g., Bell, 1993) and on the design of curriculum materials (Remillard, Herbel-Eisenmann, & Lloyd, 2008).

Research findings

We discuss how a focus on the big ideas in school algebra (e.g., Watson, 2009) can support teachers' subject knowledge whilst making the curriculum seem more manageable to teachers. In addition, we

consider ways in which the mathematical use of formative assessment may be exemplified and how a 'connectionist' approach to the teaching of mathematics may be encouraged (Askew et al, 1997). Finally, we suggest ways in which such an approach can be disseminated more widely. In particular, we discuss how curriculum guidance and textbooks might be better designed to facilitate more mathematically coherent and engaging teaching.

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