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UNDERSTANDING THE PRIMARY MATHEMATICS CLASSROOM [1]

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This paper examines 3 short case studies in year 1 mathematics classrooms as part of a larger project investigating the impact of the recent changes in mathematics education against the backdrop of the work of Bennett et al. and Desforges and Cockburn in the 1980's. Initial findings suggest that, although elements of teachers' thinking and practice have changed, much remains the same and, to some extent, the recent innovations have complicated matters for teachers.

BACKGROUND

The learning and teaching of primary mathematics remains a pressing research, policy and practice issue. The last eighteen years have seen dramatic changes to the way primary school pupils are taught mathematics in England and Wales. The introduction of the National Curriculum (NC, 1989), Standard Assessment Tests (SATs, 1992) and more recently the National Numeracy Strategy (NNS, 1999) were undoubtedly the three most important initiatives during this time. But have they fundamentally altered pupils' attainment in mathematics and, in particular, their conceptual understanding of the subject? Have they enhanced teachers' thinking and practice or has little changed?

The theoretical work of Walter Doyle in the late 1970s and early 1980s (1979, 1981 and 1983) described classrooms as information rich, ecological environments in which teachers and pupils are engaged in continuous reciprocal adjustments of setting and delivering work with cooperation and order potentially at stake. One of the outcomes of such an arrangement, he argued, is that learners 'exchange performance for grades' (Doyle, 1979). Desforges and Cockburn's (1987) empirical work suggests that pupils do not always do so in a conventional manner: indeed a significant minority of children successfully complete the tasks they are set in mathematics sessions without using any mathematics. Desforges and Cockburn further support Doyle's model when they concluded that, despite their best intentions and perceptions, teachers were very rarely able to engage children in higher order mathematical thinking. In essence, the mastering of procedures and not concepts was seen by teachers and pupils as the measure of success in primary mathematics classrooms. Such findings echoed with the conclusions of Cockcroft (1982) who, in his report noted that, although pupils' basic computational skills were in place their pupils' ability to recognise, represent and solve problems were not. This was the background for the studies (Bennett, Deforges, Cockburn and Wilkinson, 1984; Cockburn, 1986; Desforges and Cockburn, 1987) the current research replicated.

A number of studies have focused on the impact of the recent large policy changes. Three are of particular relevance. The first - the 8-year PACE Study (1989-1997) - was conducted by Pollard and his team (Pollard and Triggs, 2000; Osborn, McNess and Broadfoot, 2000) and involved 48 English Schools during the early years of the National Curriculum. During this time they noted that the time spent on mathematics remained relatively unchanged. They observed however that the quantity of mathematics increased as pupils progressed up the school and their perceptions of it altered with pupils in years 5 and 6 being 'hardly conscious of doing any "Maths with problems and games"' (p 73, Pollard and Triggs, 2000). From this one might assume that opportunity for higher order thinking were limited and, indeed, the findings suggest that many pupils were largely concerned with procedures and getting the right answer. Certainly a small minority of high achievers enjoyed their work and derived intrinsic motivation from the subject but these data do not, however, suggest that there was a marked increase in the number of mathematics tasks demanding conceptual understanding since the original work of Bennett and his colleagues.

The Leverhulme Study (1997-2002) focused specifically on the teaching and learning of mathematics in the primary classroom. The aims of this 5-year study were many, but references were made to issues of matching. In particular, in the context of assessing the impact of the whole class teaching part of the NNS, Brown et al. (2000) report that, 'Some high attaining pupils […] expressed their frustration at their progress being held back by the whole class teaching emphasis, which tends to be pitched at the needs of the middle of the group.' (p 662). This lack of matching and apparent failure to engage higher order thinking skills highlights possible sources of frustration and even maybe disengagement with the subject.

Galton et al. (1999) revisited findings from the ORACLE study (Galton et al., 1980) twenty years on, in the light of the changes in teaching policy. Among the focuses of this study were teaching practice (has this changed in any way since the introduction of the NC?), the balance between the different subjects taught in the primary classroom and the impact of the whole class teaching prescribed by the NNS and NLS on pupils' learning. Particularly relevant to the current study are the findings in pupils' performance in 'basic skills' (Galton et al., 1999, p 151) with respect to mathematics. Here, the authors observed that the situation is somewhat reversed from that in 1976 (the year of the original study) with pupils attaining, 'higher scores in mathematics concepts than in problem solving'. The explanation the authors give of this finding is 'the decrease in time set aside for the mathematics curriculum and problem solving activities in particular' (ibid. p 153). The question of the rise of pupils' conceptual understanding of mathematics tasks is however not addressed in detail here.

Clearly issues of matching and monitoring the presence of high order thinking skills in teaching mathematics in the primary classroom are present in the current literature. What is missing is an in-depth analysis of how the changes in policy have affected these issues.

RATIONALE FOR THE CURRENT RESEARCH

In the 1980s the first presenter was involved in two major research studies. The first – Bennett, Desforges, Cockburn and Wilkinson (1984) – concluded that 57% of tasks in early years mathematics classrooms were mismatched with high attainers frequently being underestimated and low attainers often being overestimated. The second study – reported in 1986 and 1987 (Cockburn, 1986; Desforges and Cockburn, 1987) – observed that, despite teachers' best intentions, mathematics lessons involving higher order thinking skills (Doyle, 1983) were extremely rare in early years' classrooms. They also noted that whilst children's predominant strategy was to follow their teacher's instructions, there was a plethora of alternative routes in operation. In many cases achieving the correct result was the sole aim: engaging in a mathematical process was not on the pupils' agenda. This study re-examines these findings in the light of changes in educational policy in the past 18 years and in particular it aims at exploring if some of the claims of the NNS Framework have been upheld. This paper specifically considers teachers' thinking and practice with particular reference to whole class teaching and the maintenance of pupil confidence.

The issue of correctly matching pupils' attainment levels to tasks assigned to them appears to be crucial among the goals of the NNS. The introduction to the Framework for the National Numeracy Strategy states,

> 'The Framework illustrates the intended range and balance of work in primary mathematics to make sure that pupils become properly numerate…. Its purpose is to help primary and middle schools, and special schools with primary-age pupils, to set appropriately high expectations of their pupils and understand how pupils should progress through the primary years' (p.2)

Later in the Framework the concept of 'properly numerate' is expanded,

> 'Numeracy is a proficiency which involves confidence and competence with numbers and measures. It requires the understanding of the number system, a repertoire of computational skills and an inclination and ability to solve number problems in a variety of contexts' (p.4)

Alexander (2000) argued that the problems of low expectations and pupil under achievement at primary level would be reduced if '…the curriculum experiences which the teacher provides; and…the knowledge and skill which the teacher needs in order to do so' were addressed (p 26). Since then standards for initial teacher training have been introduced (DfEE, 1998; DfES, 2002). These have been particularly rigorous for the 'core' subjects and, of relevance here, trainees have been required to demonstrate a high level of mathematical competence and pedagogical skills before qualifying to teach in primary school.

If the overall approach of the NNS has been successful, then one might reasonably assume that teachers' ability to match tasks to pupils' attainment levels has been

enhanced. It could also be argued however that the emphasis on whole class teaching – which is a key feature of the National Numeracy Strategy – reduces the possibility of matching. In fact in recent studies (see Brown et al., 2000) have shown little evidence of the effectiveness of whole class teaching and other aspects of the NNS. For example, it appears that "the topic of the lesson does not always correspond to their [*low attainer pupils*] areas of greatest needs" (p.662).

AIMS AND OBJECTIVES

In the light of what is stated above, the research monitored the impact of the above-mentioned changes, focusing on classroom processes in general and on teachers' success in engaging children in higher order thinking skills and matching in particular. This paper examines findings which specifically relate to teachers' thinking and actions when using the Numeracy Strategy for whole class teaching.

METHODS

This paper focuses on an ongoing 14 month study which replicates the methods used in Cockburn (1986). Particular strengths of this approach were, '…the variety of techniques employed to accumulate – and cross check – data' (Cockburn, 1986 p 90) and '…the unusually intense – i.e. daily – period of data collection' (ibid., p 90).

Selection of participants: Six year 1 teachers – representative of national age range and gender - were selected to take part in the project. The participants were selected from among teachers who obtained outstanding OFSTED results. The decision to work with only the best teachers provided the best opportunity to investigate the potential success of the new reforms.

In addition, within each classroom, six target children – selected through discussion by the teacher and the researcher – who represented the attainment range within the class (i.e. a high, mid and low attaining male and female) were chosen.

Data collection: The aim was to observe what is happening in the best primary mathematics classrooms, each over a 3-week period. Detailed, semi-structured interviews (see, for example, Erlwanger, 1975) were conducted with teachers prior to the 3-week observation and then, more briefly, before (pre-task interviews) and after (post-task interviews) each mathematics session. These ascertained their aspirations, concerns, reflections and future plans particularly in relation to the 6 target pupils (see below). In addition all mathematics sessions during this period were observed and field notes taken. On three occasions lessons were videotaped. On the same day these were followed by stimulated recall interviews (Cockburn, 1986) with each teacher to further illuminate the teachers' actions and thoughts during the teaching process.

Particular attention was given to the target children. Immediately prior to the 3-weeks' observation period each of these children was interviewed by one of the researchers and took an individually tailored diagnostic test based on the mathematics already covered, and about to be covered, by the teacher. One or two of the target

pupils was observed each mathematics session and then they were interviewed using a criterion referenced test to assess their understanding and the match of the task to their attainment. The interviews explored their engagement and their appreciation of the purpose of the exercise. (For example, was the product more important than the process?).

Data analysis: Analytical techniques replicated those employed in Bennett et al. (1984); Cockburn (1986) and Desforges and Cockburn (1987). More specifically, prior to each lesson the teachers' overall aims and those specific to the target children were documented (pre-task interviews) and later classified as procedural, conceptual or both in intention. These classifications originated from an in-detail analysis of the pre-task interviews aimed at identifying 'units of meaning' (Cohen and Manion, 1994) and at categorising them. Following each session the teachers' views on the success of the lesson (e.g. aspiration versus perceived reality) was also analysed using the same techniques. In addition, the data collected from the video stimulated recall interviews was:

- …reviewed in the light of the original Bennett et al. (1984) and Desforges and Cockburn (1987) studies;
- …analysed in the spirit of data grounded theory (Glaser and Strauss, 1967) to determine whether any new material is evident. Again a reliability check will be done on 10% of the data.
- …analysed in the spirit of "speculative questioning" (Belton, 2000) techniques.

INITIAL FINDINGS AND DISCUSSION

Of particular relevance to this paper the following general initial findings are noted:

i) Issues other than mathematics play a major role in teachers' thinking and actions.

ii) As with the studies in the 1980's (Bennett et al., 1984; Desforges and Cockburn, 1987), teachers frequently describe lessons as focusing on higher order thinking skills but, in reality, the majority of sessions are process oriented rather than striving for underlying understanding.

iii) Preliminary findings suggest that levels of matching are similar to those 20 years ago with teachers having a tendency to overestimate low attainers and underestimate high attainers.

iv) Teaching numeracy to year 1 children in one-hour sessions is proving to be a problem particularly at the beginning of the academic year when the children's concentration spans are still relatively short.

v) As with the Desforges and Cockburn study (1987), year 1 teachers are very anxious to foster pupil confidence and, if they deem it necessary, they will overlook what they consider to be minor errors in order to do so. For example one accepted '41' for '14' when a child wrote it on his board as part of a class discussion on numbers up to 20.

vi) Pupils' individual learning styles seem to play a more significant role in teachers' planning than in 1980's.

An extract from an observation protocol

Background of the observation: During this week the class teacher, Mrs K, aims at introducing basic facts about subtraction. This excerpt of an observation protocol is taken from day 2 (Tuesday) of the week.

After a warm up in mental calculations (about 10 minutes) done with all the children sitting on the carpet , Mrs K introduces the aims of the lesson. On the interactive white board there is written:

In Maths today we will be learning to take away.
We will take away 1,2,0 and all today.
How many different words do you know that mean take away?

The teacher asks one of the children to read what is written on the board and the child reads, finding only the word 'mean' difficult. Mrs K recalls what was done in the lesson yesterday: the class had learned two words that indicate take away. When Donald is asked he replies 'add'. Mrs K now has on the board the following list:

5 take away 1 is
4 take away 1 is
3 take away 1 is
2 take away 1 is
1 take away 1 is

She asks about the first line in the list. What is the answer? Conrad replies 4, and then explains that one step back from 5 is 4. Mrs K points at the next line in the list: 4 take away 1 is… Alex replies 3, one step back from 4. Next line now: 3 take away 1 is… Jamie shouts 2 because it is one step back. Next: 2 take away 1 is… 0 shouts Donald.

In the proposed presentation the authors will present three case studies which illustrate these findings and will act as a catalyst for further discussion. For example the first of these will focus on Donald who is an able child who did exceptionally well in his pre-observation interview. Classrooms observations and interviews suggest that his teacher is very thoughtful, able and committed. Early session observations however indicate that Donald was largely underestimated and bored. In marked contrast, on day 7 he gives the impression of being utterly confused by the work and unable to complete tasks successfully achieved in the pre-observation interview 2 weeks earlier (see extract above). He was not ill and the teacher's performance was of her usual high standard: so what effected the change? The authors will present some hypotheses and open the discussion to consider how – or, indeed, whether – teachers' and pupils' experiences and learning may be enhanced.

NOTES

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