

# Developing teaching and learning in primary mathematics: Lessons from England's National Strategy

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## **Introduction**

Introduced almost ten years apart, the National Curriculum and the National Numeracy Strategy each were intended to improve the teaching and learning of primary mathematics in England. Although these initiatives have many things in common, there are also some key differences. The National Curriculum set out the content to be taught and broad expected learning outcomes, leaving teachers to decide on how to achieve these. The National Numeracy Strategy, in addition to specifying content and outcomes, set out detailed directions for teaching methods. The National Curriculum was twice revised and reduced in response to teachers saying that its level of detail made it unmanageable. The National Strategy contained far more detail than the original National Curriculum but shows no signs of being reduced. The National Curriculum is mandatory; the National Numeracy Strategy is not mandated. And while the National Curriculum did have an impact in ten years, it is slight in comparison with the impact of the National Numeracy Strategy in only four years.

Training, both in and out of school, videos, self-study packs, 'leading mathematics teachers' to go and observe, classroom-based support from over 400 consultants: no teacher has been able to escape the trawl-net of initiatives spread out by the National Numeracy Strategy. Developed in response to the government's concerns over standards in mathematics attainment, particularly as suggested by England's positioning in international league tables (Harris, Keys, & Fernandes, 1997; Keys, Harris, & Fernandes, 1996), the National Numeracy Strategy's extensive and intensive programme of dissemination ensured that key messages were passed down to all teachers.

The introduction of the National Numeracy Strategy happened to occur at the midpoint of a large-scale longitudinal study of teaching and learning in primary mathematics that was being carried out by a team at King's College, London: the Leverhulme Numeracy Research Programme. The pre-cursor to the National Numeracy Strategy – the National Numeracy Project – was being developed at the start of the Leverhulme Programme, but in putting the research proposal together we did not anticipate the speed at which a strategy would be 'rolled out' into all schools and so did not design the research to specifically examine the impact of such systemic reform. Nevertheless the data collected as part of the Leverhulme programme did allow us to examine some aspects of the impact – intentional and unintentional – of the National Numeracy Strategy. I address these aspects through looking at the questions:

- Have standards improved as a result of the Strategy?
- Has teaching changed and if so in what ways?
- Are there unintended effects of the reform, both positive and negative?
- Are there implications for other teachers, researchers and policy makers?

Before turning to these questions, I provide some background information on the Leverhulme Numeracy Research Programme. The key features of the National Numeracy Strategy are also set out, to provide a context for the consideration of the impact of the intervention. But first a brief word about the meaning of numeracy in this context.



### **Mathematics or numeracy?**

A year before the introduction of the National Numeracy Strategy the government had introduced a National Literacy Strategy; the use of ‘numeracy’ thus echoed with ‘literacy’. It also seems likely that ‘numeracy’, as opposed to ‘mathematics’, was perceived as carrying connotations of ‘arithmetic’ and so was chosen to satisfy the ‘back to basics’ lobby.

In the pre-cursor to the Strategy, the National Numeracy Project, the emphasis was indeed primarily on number work, with numeracy defined as:

“a proficiency which involves confidence and competence with numbers and measures. It requires an understanding of the number system, a repertoire of computational skills and an inclination and ability to solve number problems in a variety of contexts.”

(Department for Education and Employment (DfEE), 1999b, Introduction, p.4)

The National Numeracy Project was only intended to be implemented for three days a week with teachers covering non-numerical aspects of the mathematics curriculum in the other two days, but the ‘Framework of teaching mathematics from Reception to Year 6’ (Department for Education and Employment (DfEE), 1999b) that accompanied the National Numeracy Strategy covers non-numerical aspects of the mathematics curriculum and the Strategy is expected to be taught five days per week. Hence numeracy has come to be synonymous with mathematics in the minds of teachers and children alike. I shall use the terms numeracy and mathematics interchangeably: both should be read as ‘school mathematics.’

### **Leverhulme Numeracy Research Programme**

The national concern about standards of literacy and numeracy in England in the late 1990s led the Trustees of the Leverhulme Trust, a charitable foundation, to offer to fund a £1 million 5-year study on low attainment in basic skills at primary level (literacy and/or numeracy). The competition for the funding was won by a team based at the Department of Education and Professional Studies, King’s College London, for research focused entirely on numeracy. The resulting programme, known as the Leverhulme Numeracy Research Programme, ran from 1997 to 2002 with the aim:

to take forward understanding of the nature and causes of low achievement in numeracy and provide insight into effective strategies for remedying the situation.

The research design included a large-scale longitudinal study (the “Core Project”) and five case-study projects (five “Focus Projects”). The Core Project was a longitudinal survey monitoring attainment of 2000+ children in each of two cohorts, observing lessons and interviewing teachers and head teachers (principals). Although the research programme lasted for only five years, by having an overlap in the two cohorts

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we were able to study all seven years of primary schooling in England. Table 1 indicates the overlapping structure of the cohorts of children followed. Each cohort was drawn from 38 schools (initially 40) and we tracked the progress of all the relevant classes in each of these schools: 75 classes in total for each cohort.



Cohort	1997/8	1998/9	1999/00	2000/1	2001/2
1	R	Y1	Y2	Y3	Y4
Age	4/5	5/6	6/7	7/8	8/9
2	Y4	Y5	Y6	Y7*	
Age	8/9	9/10	10/11	11/12	

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Table 1. Progression of Cohorts 1 & 2 (\* only a small number of children were tracked into Year7)

We tracked children’s progress mainly through assessing all the children (except those in Reception classes who were considered to be too young) in October and June of each year of the study. All classes were visited at least once each year, when a mathematics lesson was observed and the class teacher interviewed. The head teacher and mathematics co-ordinator (manager) in each school were also interviewed every year to explore developments, as they perceived them, in the teaching and learning of mathematics in their school.

One of the Focus Projects – Case studies of pupil progress – followed 60 of the children in the Core Project schools in more detail. In five of these schools, we selected children of varied attainment, six from a Reception class (pupils aged 4-5 years) and six from a Year 4 class (pupils aged 8-9 years). These children were observed and informally interviewed in two blocks of five lessons each year, and their written work collected. This data helped us to explore in detail some of the larger patterns of progress that were observed in the Core Project data. (For fuller details of the Leverhulme Numeracy Research Programme see Millett, Brown, & Askew, 2004)

**National Numeracy Strategy: Key changes**

Key features that the National Numeracy Strategy set out to change were:

- Curriculum
- Planning
- Teaching, both pedagogy and didactics

**Curriculum changes**

Three main aspects of the primary mathematics were subject to reform within the strategy:

- an increased emphasis on number and on calculation, especially mental calculation
- less time on space and shape, measurement, data handling
- a detailed breakdown of curriculum into teaching objectives (the ‘Framework’)



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### *An increased emphasis on number and on calculation, especially mental calculation*

Pupils, when presented with a calculation, were to be taught to be able to decide whether they were confident to reach an answer working mentally, rather than use a paper and pencil algorithm. To support this, they were to develop a repertoire of mental strategies from which they could select according to the type of calculation and the numbers involved. The teaching of written calculations was to be introduced at a later stage in schooling (when children were aged 8-9 years) than had been the common practice (when children were aged 6-7 years) but informal written procedures were to be encouraged, as a support to mental calculation. Calculators were discouraged, although use of them was to be taught in specific lessons starting from Year 5 (age 9-10 years)

### *Less time on space and shape, measurement, data handling*

The increased emphasis on mental calculation meant that less attention would be given to other aspects of the curriculum. Overall, around three fifths of teaching time was to be devoted to number work, with all other aspects covered in the remaining two fifths.

### *Detailed breakdown of curriculum into teaching objectives (the 'Framework')*

The National Curriculum set out the curriculum in 'Key Stages': for five- to seven-year olds (Key Stage 1) and for seven- to eleven-year-olds (Key Stage 2). In contrast, the National Numeracy Strategy provided teaching and learning objectives for each year of primary schooling, and with a greater level of specificity than that set out in the National Curriculum. These yearly objectives were listed, with detailed examples to elaborate them, in a key document – 'The Framework for Teaching Mathematics from Reception to Year 6' (Department for Education and Employment (DfEE), 1999b).

The Framework breaks the mathematics curriculum down in increasing levels of detail. This breakdown starts with identifying five curriculum strands of: number and the number system; calculations; solving problems; handling data; measures, shape and space. Each strand is presented in seven yearly teaching programmes, and broken down into a number of sub-sections. For example, within the calculation strand are sub-sections on: understanding multiplication and division; rapid recall of multiplication and division facts; mental calculation strategies ( $\times$  and  $\div$ ). Within each strand's sub-sections there are a series of specific teaching objectives. Finally, these detailed objectives are re-presented later in the Framework with examples of expectations of what children should be able to do in each year of their primary schooling.

To illustrate the difference in detail within each initiative, the National Curriculum in its teaching objectives for Key Stage 2 says, for example, this, in total for four years of schooling, about teaching mental strategies for addition and subtraction:

- "d) recall all addition and subtraction facts for each number to 20
- e) work out what they need to add to any two-digit number to make 100, then add or subtract any pair of two-digit whole numbers; handle particular cases of three-digit and four-digit addition and subtraction by using compensation or other methods (for example,  $3000 - 1997$ ,  $4560 + 998$ )"

(Department for Education and Employment (DfEE), 1999a, p. 69)

In contrast, a typical learning outcome for a Year 4 pupil (aged 8-9 years) in the section on mental strategies for addition and subtraction in the 'Framework' is:

Find what to add to a two- or three-digit number to make 100 or the next higher multiple of 100

- Respond to oral questions and explain method:

What must be added to 37 to make 100? 432 to make 500?

- Work mentally to complete written questions like:

$3200 + \quad = 4000$        $8400 + \quad = 9000$

(Department for Education and Employment (DfEE), 1999b, Y456 examples, p.44)

And this is only one of some 25 such strategies listed.

### ***Planning changes***

The Strategy training encouraged teachers to create weekly plans for mathematics by selecting from the lists of objectives provided in the Framework: teachers were thus expected to reduce their dependency on textbooks as the primary resource for planning. The Framework was to be used as a day-to-day reference point and published materials referred to, if at all, only as a source of further examples. All schools were provided with an example of what the result of this approach to planning might look like – a set of 'medium term plans' with the objectives in the Framework organised in blocks to be covered in a group of lessons (over 1-3 weeks). Although teachers were encouraged to use this example as a model on which to base their own organisation of the objectives, the majority of schools took to using the example as given as a basis for their daily planning.

### ***Teaching changes***

A substantial part of the emphasis in establishing the National Numeracy Strategy was in encouraging all teachers to engage in the pedagogic practice of implementing a 'daily dedicated mathematics lesson'. This emphasis had come about because of a perception in policy circles that not all children were being taught mathematics every day of the school week, hence the requirement for a 'daily' lesson. Timings for these lessons were specified: the youngest pupils would have a lesson of around 40 minutes, but this was to be extended to a full hour by the later years of primary school. The lesson was to be 'dedicated' in that only mathematics was to be taught during that time (a popular practice promoted by the Plowden Report (Central Advisory Council for Education (England) (CACE), 1967) in the sixties was the 'integrated lesson' where groups of pupils worked concurrently on different curriculum areas, or latterly, different aspects of mathematics worked on by different groups in the same lesson. Although much reduced in popularity by the 90s, it was these practices that were being discouraged through the 'dedicated' mathematics lesson).

Further to all this, this daily, dedicated mathematics lesson was to be organized according to a three-part template

- a 10-15 minute 'starter' of oral/mental skills practice
- a block of 'direct interactive teaching' of the whole class and groups
- a final 10 minutes of plenary review.

During the middle block of direct interactive teaching, teachers were encouraged to group the children into three or four groups, the composition of these groups based on



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attainment – a ‘top’ group, one or two ‘middle’ groups and a ‘lower’ group. When not teaching the whole class, the teacher could work intensively with one of these groups.

In addition to these pedagogic changes, certain didactic changes were also introduced. For example, emphasis was placed on the use of the empty number line as a key didactic tool for supporting the learning of mental strategies for addition and subtraction Framework (Department for Education and Employment (DfEE), 1999b, Y123 examples, p. 45).



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### **National Numeracy Strategy: Sources of dissemination**

These changes were introduced into schools through a systematic national training programme based on standard packages of training materials, providing timetables, overhead transparencies to illustrate key points, and videos to demonstrate ‘best practice’. Training in each Local Education Authority (School District) was organised for teachers from each school by specially appointed trainers acting as consultants and working to regional directors, under a national director. In all schools the training was run by school mathematics co-ordinators, with additional support from the consultants provided for low-performing schools, both in-school and via local courses.

Initially, three teachers from every primary school attended a three-day training where they were introduced to the template for the daily, dedicated mathematics lesson and the ‘Framework’. Money was provided to allow every school to close to pupils for two days and for these three teachers to cascade the three-day training to all other teachers. Over and above this a network of ‘leading mathematics teachers’ was established. Teachers were released to visit and observe ‘effective teaching’ in practice in the classrooms of these leading teachers.

For those schools considered to be under-performing as judged by pupil attainment on national tests – around a third of all primary schools – a further five-day training course was provided with three teachers from each of these schools attending. (Subsequently this training was made available to all schools irrespective of ‘performance’.) Under-performing schools received further support from a ‘numeracy consultant’ who would visit schools to help with planning, work in classrooms and run further training.

### **Impact on the Leverhulme Numeracy Research Programme**

In designing the research to address the aim of identifying ‘effective strategies’ that might be linked to raising standards we had expected that our lesson observations would cover a range of styles of pupil organisation and teaching. Patterns in these styles could be looked for and any associations with pupils’ gains on our assessment investigated. A major impact on our expectations was the adoption of the ‘three-part lesson’ as the norm for nearly all the mathematics lessons we observed in the latter half of the study.

Not surprisingly, however, at least to us as researchers, but perhaps disappointingly to policy makers, the patterns of attainment that our assessments showed were no different after the introduction of the three-part lesson than they had been before. For example, the average gains that pupils made between each administration of our assessments were fairly consistent across all years of our study (although the size of the gains did differ for different age groups).

There was, however, one unexpected bonus to our research programme arising from the introduction of the National Numeracy Strategy and the three-part lesson. We had designed the two cohorts so that one started with a group of Year 4 pupils and the



other ended with a group of Year 4 pupils. Year 4 was thus to be an ‘anchor’ year, linking the two cohorts together: as these were classes in the same school, albeit five years apart, we expected their experiences to be reasonably similar and they would thus enable us to link the two cohorts together. Table 2 shows the year of introduction of the Numeracy Strategy (1999/00) and the positioning of the two Year 4 cohorts relative to this.

Cohort	1997/8	1998/9	1999/00	2000/1	2001/2
1	R	Y1	Y2	Y3	Y4
Age	4/5	5/6	6/7	7/8	8/9
2	Y4	Y5	Y6	Y7*	
Age	8/9	9/10	10/11	11/12	

Table 2. Impact of the introduction of the National Numeracy Strategy on the Leverhulme Numeracy Research Programme

But instead of the two sets of Year 4 classes having had similar experiences they turned out, thanks to the National Numeracy Strategy, to have had quite different experiences. The older cohort when we first tested them were completely ‘untouched’ by the National Numeracy Strategy, whilst when the younger cohort reached Year 4 they had had three years’ experience ‘Strategy lessons’. We were thus provided with data that might shed some light on the effects of the Strategy, data that provides the basis for the findings now discussed.

### Did standards improve as a result of the Strategy?

Figure 1 shows the percentage of eleven-year-olds reaching the expected level of attainment (level 4) in National Tests. In 1998 the National Tests for mathematics were changed: an orally administered mental mathematics test was added to the two written papers. This change in the extent and nature of the test may account for the dip in attainment in 1998 as teachers and pupils were not used to the new format and expectations. As the curves for mathematics and English both show, there had been a steady increase in attainment in the years prior to the introduction of the National Numeracy Strategy. And, setting 1998 aside for mathematics, the trajectory of increased attainment since the introduction of the National Strategies in Literacy (1998) and Numeracy (1999) is not very different to the prior ones.

Perhaps more striking is the performance in Science over the same period. Science is the third ‘core subject’ on which all pupils are tested nationally. Although no Strategy has been developed towards increasing attainment in Science, the National Test scores for science out-perform English and mathematics both before and after the introduction of the National Strategies for both subjects.

Turning to data from our Leverhulme Programme, Table 3 shows the difference in test scores for the two cohorts of pupils at the beginning and end of their time in Year 4. Before the introduction of the strategy, Year 4 (8-9 years old) pupils that we tested scored on average 52% in the October and 62% in the June. Five years later, Year 4 pupils, in the same schools, who, prior to Year 4, had had two years experience of the Strategy scored slightly higher with 55% and 65% in October and June respectively. Converting these gains into age equivalents, our data suggests that pupils

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who had the benefit of the strategy were performing at a level equivalent to pupils two months older than those who had not had experience of the strategy.



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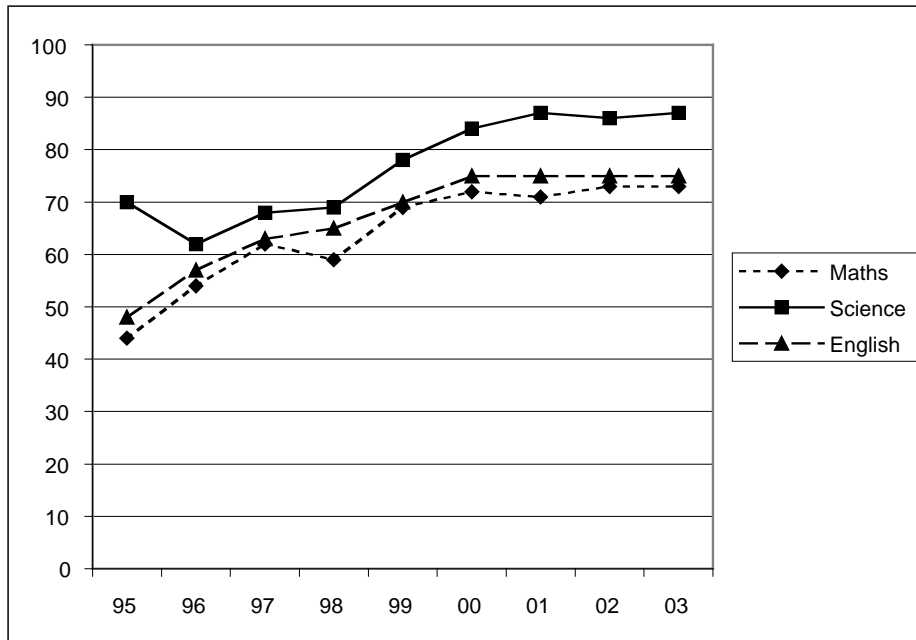


Figure 1. Percentage of 11-year-olds reaching expected attainment in national tests

Note that in each year the gains made within the year were the same: pupils gained 10% on average irrespective of whether or not the teaching that they experienced had been influenced by the Strategy. In general terms our data shows that the strategy had had a positive, but slight, impact on pupil attainment.

	1997-98	2001-02	Gain	Age gain equivalent	Effect size
<b>October</b>	<b>52%</b>	<b>55%</b>	<b>+3%</b>	<b>+2 months</b>	<b>0.17</b>
<b>June</b>	<b>62%</b>	<b>65%</b>	<b>+3%</b>	<b>+2 months</b>	<b>0.18</b>

Table 3. LNRP test results for Year 4 pupils pre and post the introduction of the National Numeracy Strategy (n=2000+ for each cohort)

Table 4 breaks down the June assessment scores for each cohort into different attainment bands. In the run up to the introduction of the National Numeracy Strategy



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there was much rhetoric about the ‘long tail of underachievement’ in English mathematics. Apparently, the spread of attainment was greater in England than in comparable countries and one aim of the Strategy was to narrow the attainment range. Although based on only one year-group, our data shows that three years into the Strategy, the range of attainment, if at all changed, had widened rather than narrowed. The top five percent of pupils had gained two percentage points while the bottom five percent had dropped two points. The greatest gains were made by the middle 50% who were performing 4 percentage points higher than the equivalent classes prior to the strategy. With the Strategy’s emphasis on more whole class teaching, it is reasonable to assume that this result could be due to the lesson content being pitched at the middle group. In addition, interview and observation data from the case study pupils shows that the lower attaining pupils were less likely to be actively engaged with the oral and mental starter parts of the Strategy lessons, thus missing out on opportunities to discuss mathematical ideas.

Attainment group	June 1998	June 2002
<b>Top 5%</b>	<b>90</b>	<b>92</b>
<b>Top 10%</b>	<b>88</b>	<b>90</b>
<b>Top 25%</b>	<b>82</b>	<b>85</b>
<b>Middle 50%</b>	<b>63</b>	<b>67</b>
<b>Lowest 25%</b>	<b>39</b>	<b>40</b>
<b>Lowest 10%</b>	<b>30</b>	<b>29</b>
<b>Lowest 5%</b>	<b>25</b>	<b>23</b>
All	62	64

Table 4. Change in mean % correct for Year 4 attainment groups

Breaking down our assessment into different mathematics domains reveals further distinctions in patterns of attainment. Table 5 shows that greatest gains were made on items (n=31) assessing whole number and the number system. This is likely to be a result of the emphasis in the framework on work in this area and a shift in the teaching of place value. The Strategy training had put emphasis on increased use of number lines to model whole number and a move away from describing, say, 45 as ‘four tens and five units’ towards describing it as ‘forty and five’. Our observation data showed that these approaches were being taken up in classrooms.

Domain	n	1998	2002	Difference
Number system	31	63	69	+6
Addition/subtraction	18	60	65	+5
Multiplication/division	9	69	68	-1
Fractions/decimals/ratio	13	41	42	+1
Solving real life problems	10	40	39	-1

Table 5.Changes in mean % correct for groups of age 8/9 items (June)

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The slight dip in scores on items (n=13) assessing solving real life problems is not surprising given the Strategy's decreased emphasis on this aspect of the curriculum. But more surprising is the dip on the multiplication and division items, but our lesson observation data showed that, despite the training, changes in methods of teaching multiplication and division were much less pronounced than for number or addition and subtraction,

So the answer to the question 'Did standards improve as a result of the strategy?' is a qualified yes. Overall standards rose in the years following the introduction of the Strategy, but fell short of targets being set. Given that over this period the standards in science rose more sharply, whether the rises in mathematics were a result of the Strategy is debatable. Looking at mathematical domains it looks likely that the changes to the curriculum had had an impact and, given that the overall gain in a year was similar before and after the introduction of the Strategy, these curriculum changes appear to have had more impact than the pedagogic changes. Indeed the slight increase in the range of attainment within a year group after the introduction of the Strategy suggests that the pedagogic changes had not been of benefit to all pupils.

### **Did teaching change and if so in what ways?**

Our data does indicate that there were substantial changes to both planning and teaching and that these changes were the result of the introduction of the National Numeracy Strategy.

#### ***Planning in 2001/2, in comparison with 1997/8***

Two things to note here. First, teachers interviewed in 2001/2 reported that they engaged in more frequent planning than they had done before the Strategy. This included more planning both for the whole class and for targeted groups of pupils. The main resource that teachers reported using for their planning was the Strategy's framework, with around two thirds of the teachers interviewed in 2001/2 (n=150) reporting that they referred to the Framework at least weekly. The majority of these teachers also reported following the sample medium-term plans that the Strategy had provided. The third of teachers not reporting using the Framework for planning were, in the main, working from newly published schemes and textbooks; schemes and textbooks that carried the promise of being matched to the Framework.

The second major change was the shift from activity-led lessons to objectives-led lessons. Before the Strategy, when asked about how they selected lesson content most teachers talked about finding activities that were linked to a mathematical topic, but, equally important, were likely to engage children's interest. After the Strategy, teachers had universally adopted the practice of starting to plan lessons by taking teaching objectives from the Framework and then finding, or creating, activities that they considered would fit with the objectives.



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### ***Lessons in 2001/2, in comparison with 1997/8***

The most obvious change in 2001 was the number of lessons that fitted with the Strategy's model of the three-part lessons. In all 93% of the lessons that we observed in 2001/2 were classed as conforming to the three-part template. Looking back at the lessons of 1997/8 only 12% were considered to have anything like a three-part structure. Allied with this was also a substantial increase in the amount of whole class teaching observed.

The lessons observed later were also longer. Lessons in 2001/2 lasted, on average 61 minutes compared with an average of 54 minutes in 1997/8. Taking out, however, the time given over to the mental and oral starter, and the drawing together plenary, then the 2001/2 lessons actually had on average a shorter main teaching part: 40 minutes compared to 47 minutes in the pre-Strategy lessons.

As indicated above we did observe more use of the didactic tools recommended by the Strategy, particularly the use of empty number lines and informal calculation methods for addition and subtraction. But the styles of teaching and tools used for developing understanding of multiplication and division pre- and post-Strategy were indistinguishable: usually a mix of rote learning of multiplication tables and some version of an algorithm for long multiplication (this despite emphasis in the Strategy on the use of grid and area models for long multiplication).

So did teaching change? In terms of pedagogy – lesson organisation and structure – the Strategy appeared to have had a big impact. But its impact on didactics – the models and tools used for teaching particular topics – was less obvious and our data suggests that the impact of the Strategy on this was patchy.

Along with this variation in the intended impact of the Strategy, our data indicated that there might have been other, unintended effects. It is to these unintended effects that I now turn.

### **Are there unintended effects of the reform, both positive and negative?**

I now turn to considering some of the unintended effects that appear to be a result of the Strategy's directives on:

- Direct, whole class teaching
- Manageable differentiation
- Objectives driven lessons

I address these unintended effects by looking at the policy statement, speculating on the principles and perspectives that the policy might be based upon, and our evidence for the way the policy statements were being worked out in practice. I have to speculate on the principles and perspectives underlying the policy directives as these are not always explicitly spelt out in the policy documents. Whenever possible, I have tried to base these speculations on what might be considered 'best practice' reasons.

### ***Direct, whole class, teaching***

The Policy directive here was that more attention needed to be given to teaching and instruction.



“Where *teaching* is concerned, better numeracy standards occur when teacher:

- devote a high proportion of lesson time to direct teaching of whole classes and groups, making judicious use of textbooks, worksheets and ICT resources to support teaching, not to replace it.”

(Department for Education and Employment (DfEE), 1999b, Introduction, p. 4, original emphasis)

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*This appears to have been based on a perception that pupils had been spending too much time working alone in mathematics lessons: previously the perceived dominant practice had been to start pupils off working on a textbook and to allow them to progress at their own pace through this (how widespread this practice actually was is debateable). It was claimed that the pupils’ different rates of progress resulted in the children in a class being engaged with a variety of mathematical topics, which reduced the opportunities for discussion, particularly with the whole class.*

A practice introduced to address this was the three-part ‘daily dedicated mathematics’ lesson with its three-part structure.

### ***Unintended effects?***

*Tapping into collective memory and an increase in ‘transmission’ styles of teaching.*

Evidence from both the Leverhulme research and elsewhere indicated that the Strategy emphasis on using a three-part lesson for mathematics was widely taken up by teachers. The success of this was no doubt largely a consequence of the emphasis given to this within the Strategy training. But it also seemed that teachers were willing to adopt the practices because they tapped into a collective memory of how mathematics should be taught.

Several teachers in the Leverhulme schools commented that the Strategy model for lessons meant “I can finally teach mathematics the way I think it should be taught”. Lesson observations provided insight into what was meant by this: the adoption of a four-part lesson. This extra fourth part was a result of the splitting of the ‘main teaching’ part of the lesson into two: a portion of time when the teacher explained to the pupils what they had to do and a second phase when the pupils were sent off to carry out the tasks demonstrated. This part of the lesson thus frequently resembled the sort of mathematics teaching that the teachers themselves were likely to have experienced when at secondary school. At best this model set up challenges for the pupils to go off and work on, but we more often observed teachers explaining, at length, procedural work for the pupils to do. In some lessons the majority of time was given over to teacher talk with the pupils afforded little opportunity to work on the mathematics independently.

### ***Reduction in extended and investigative tasks***

Alongside this increase in ‘transmission’ teaching we noted a decrease in the number of lessons that provide pupils with the opportunity to work on mathematical tasks that required sustained engagement. In the pre-Strategy lessons observed several lessons were built around investigational activities that either involved the children in working on extended tasks or that involved short and frequent movement between group or individual work and whole class interactions; we saw hardly any such lesson post-Strategy.

### ***Manageable differentiation***

Another key Policy initiative was that strategies for dealing with the range of pupil attainment in classes had to be workable: differentiation needed to be manageable.

“Where *teaching* is concerned, better numeracy standards occur when teacher:

- ensure that differentiation is manageable and centred around work common to all the pupils in a class, with targeted, positive support to help those who have difficulties with mathematics to keep up with their peers.”

[ibid, Introduction, p 4, original emphasis]

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*This also seemed to be based on the principle of keeping the content of lessons more focused. Just as too much individualised work on textbooks would spread the mathematics covered in a lesson, so too trying too closely to meet the needs of individual pupils would spread the range of tasks worked on and again decrease the opportunities for teacher/pupil contact and discussion.*

The practice advocated here was to work with three grouping levels in classes: a group of high attainers, one or two middle groups, and a group of low attainers.

### ***Unintended effects?***

#### *Increased use of setting*

If putting the children into three levels of attainment (or ‘ability’ as more commonly used) within a class is supposed to make teaching more manageable, then, so the logic goes, putting children into three levels of attainment across classes must be even more effective. Hence many schools have moved from heterogeneous mathematics classes to homogeneous groups: to setting pupils by attainment for mathematics lessons (despite the evidence of the adverse effects of this setting (Bartholomew, 1999; Boaler, 1997).

Although explainable within the Strategy directives, this organisational move also needs to be considered in the light of the high-stakes testing that is now in place in English primary schools. One of the policy drivers intended to increase the numbers of pupils attaining the expected level of attainment (‘Level 4’) for 11-year-olds is the publication, in national and local press, of schools’ results: percentages of pupils at different levels of attainment. Crucial to schools’ pupil retention, funding, and levels of intervention from inspectors is the percentage of pupils attaining the benchmark Level 4.

#### *Inequality of opportunity*

There is some evidence that this emphasis on the numbers of pupils reaching level four, along with the move to homogeneous grouping, is leading to a “triage” approach to learners: the deployment of resources and experienced, skilful, teachers is put towards working with those pupils who are on the cusp of achieving Level 4. Pupils who are expected comfortably to reach Level 4 are not given any special attention and equally those highly unlikely to reach this level of attainment are also not given special attention. Thus, although the strategy is supposed to be raising standards of mathematics education for all pupils, the practices being developed raise a number of equity issues.

### ***Objectives driven lessons***

The policy directive here is that learning objectives needed to be shared with pupils.

“Good direct teaching is achieved by balancing different elements:

*Directing*: sharing your teaching objectives with the class, ensuring that pupils know what to do, and drawing attention to points over which they should take particular care, such as how a graph should be labeled, the degree of accuracy needed when making a measurement, or how work can be set out...”

[ibid, Introduction, p 11, original emphasis]

*This appears to be based on a perception that previously pupils had been ignorant of the purpose of activities that they worked on in mathematics lessons and the principle that raising this awareness would result in better teaching and learning*

The practices advocated, and one that appears to have been almost universally adopted, is that of writing objectives on the board at the start of lessons.

### ***Unintended effects?***

*Emphasising the teachable over the learnable*

This practice has led to a concentration on the ‘teachable’ as opposed to the ‘learnable’. For example, monitoring reports on the implementation of the strategy have noted the preponderance of lessons working on doubling numbers. But if learning outcomes have to be explicitly shared with pupils is it any wonder that teachers are more likely to choose to share and teach an objective like:

“Know by heart or derive quickly doubles and halves”

[ibid, Y456 examples, p 58]

Rather than

“Understand and use when appropriate the principles (but not the names) of the commutative, associative and distributive laws as they apply to multiplication.”

[ibid, Y456 examples, p 52]

*The tension between teaching objectives and pupils’ methods*

A second effect of the introduction of this practice has been to place teachers in tension when attempting to draw on pupil methods to develop lessons. As noted above one of the aims of the Strategy was to increase the range of mental strategies with which children were familiar and which they could draw upon to carry out calculations. But if the teacher has to specify in advance the strategy that a lesson is going to focus on, how is she to deal with the pupil who chooses to use a different strategy from the one specified?

For example, one mental strategy that children are supposed to be learning is that of ‘bridging through ten’: adding, say, 8 to 56 by adding 4 to make 60 and then adding another 4. We have observed teachers struggling to decide how to deal with pupils who, given such a calculation use a different strategy (say adding 10 to 66 and subtracting 2) when the stated objective of the lesson was learn about bridging through ten.



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### *Teacher's alternative interpretations of objectives*

Another issue here is the effect of teachers' interpretations of the objectives. As noted above, the Framework breaks the mathematics curriculum down in increasing levels of detail. Given such a detailed breakdown of objectives, supported by examples, one might expect that the interpretation of these would be unambiguous. Our observations, however, suggest that this is not the case.

For example the objective 'understand multiplication as repeated addition' appears in the examples for eight-year-olds under the objective that:

“pupils should be taught to: understand the operation of multiplication and the associated vocabulary, and that multiplication can be carried out in any order”.

[*ibid*, Y123 examples, p 46]

Only one example in the Framework elaborates this objective.

“Understand multiplication as:

- repeated addition: for example, 5 added together 3 times is  $5 + 5 + 5$ , or 3 lots of 5, or 3 times 5, or  $5 \times 3$  (or  $3 \times 5$ )”

[*ibid*, Y123 examples, p 47, original emphasis]

As this example compresses a repeated addition into a multiplication statement it seems reasonable to interpret the intention behind the objective as one of helping children to understand multiplication as more efficient than repeated addition.

In many lessons, however, our observations indicated that teachers had interpreted this objective as meaning to encourage children to use repeated addition if they could not carry out a multiplication.

### **Are the implications for other teachers, researchers and policy makers?**

Despite the caveats discussed above, the National Numeracy Strategy has had a profound impact on teaching and learning mathematics and on teachers' attitudes towards this. General changes that have come about include:

- an opening up of classrooms
- an opening up of discussion
- raising expectations regarding continuing professional development

***An opening up of classrooms.*** Prior to the introduction of the Strategy teachers in England were unused to, and frequently reluctant to, visit each other's classrooms during lessons (and especially during mathematics lessons). The setting up of visits to observe 'leading mathematics teachers', the use of in-school consultants who worked in classrooms and both taught and observed, providing time for schools' mathematics co-ordinators to be released from their own teaching and to work alongside colleagues: such initiatives have made teachers much more comfortable both with observing and being observed by others. This has not only raised awareness of the range of pedagogic practices possible when teaching mathematics but also challenged teachers to think about their expectations for pupils' attainment.

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**Opening up of discussion.** Along with the opening up of the mathematics classroom has been the opening up of discussion about mathematics teaching. Teachers have indicated a willingness to be more open about and seek help with aspects of the curriculum that they find difficult – in terms either of understanding or of teaching. The setting down of yearly teaching and learning objectives has meant that many schools have looked at their expectations for various year groups, resulting in discussions across year groups, when previously such discussion may have been restricted to being between teachers with similar aged pupils.

**Raising expectations regarding continuing professional development.** The extensive reach of Strategy training has meant that many teachers now regard professional development activity as a right rather than a privilege. Professional development activity in mathematics teaching is no longer seen as the preserve of the interested teacher, but as the right of any teacher of mathematics.

### **Bringing about systemic changes**

In terms of general lessons for those trying to bring about systemic change then the nature of the expected changes need to be looked out. The English experience suggests that if teachers believe that changes will be beneficial, and the organisational structure, training programme and support materials are sound, significant systemic changes can be made in curriculum, planning and pedagogic aspects of teaching.

However, these changes may largely only be surface level. The evidence from England suggests that it is difficult to change teachers' beliefs about 'delivering' mathematics and hence how they behave towards children, although there was some success in acceptance of children's methods as legitimate. It is also difficult, on such a large scale, to increase teachers' deeper understanding of mathematics to enable them to see connections, ask more challenging questions, and develop the didactics of the mathematics classroom.

### **References**

- Bartholomew, H. (1999). *Setting in stone? How ability-grouping practices structure and constrain achievement in mathematics*. Paper presented at the Annual BERA conference, September 1999, University of Brighton.
- Boaler, J. (1997). *Experiencing school mathematics: Teaching styles, sex and setting*. Birmingham, UK: Open University Press.
- Central Advisory Council for Education (England) (CACE). (1967). *Children and their Primary Schools (Plowden Report)*. London: Her Majesty's Stationary Office (HMSO).
- Department for Education and Employment (DfEE) (1999a). *The National Curriculum. Handbook for primary teachers in England. Key stages 1 and 2*. London: Department for Education and Employment, and Qualifications and Curriculum Authority.
- Department for Education and Employment (DfEE) (1999a). *The National Numeracy Strategy: Framework for teaching mathematics from Reception to Year 6*. London, UK: DfEE.
- Harris, S., Keys, W., & Fernandes, C. (1997). *Third international mathematics and science study. Second national report, part 1. Achievement in mathematics and science at age 9 in England*. Slough: National Foundation for Educational Research.
- Keys, W., Harris, S., & Fernandes, C. (1996). *Third international mathematics and science study. First national report, part 1. Achievement in mathematics and science at age 13 in England*. Slough: National Foundation for Educational Research.
- Millet, A., Brown, M., & Askew, M. (Eds.). (2004). *Primary Mathematics and the Developing Professional* (Vol 1). Dordrecht/Boston/London: Kluwer Academic Publishers.

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