

HOW HAS THE NATIONAL NUMERACY STRATEGY AFFECTED ATTAINMENT AND TEACHING IN YEAR 4?

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The Leverhulme Numeracy Research Programme was a five year longitudinal study of children's learning and the factors which affect it. In addition to five case-study projects, it included a longitudinal survey of two cohorts of children in 40 primary schools. The research design included assessment, lesson observation and teacher interviews in Year 4 in 1997/8, two years before the implementation of the National Numeracy Strategy (NNS), and again in 2001/2, two years after it. Additional funding for an extra year by the Nuffield Foundation allowed us to study changes in Year 4 attainment, including how the NNS affected different items and different groups of children, and to give tentative explanations for these changes deriving from lesson and interview data.

INTRODUCTION

The Nuffield Year 4 project, funded for one year from September 2002 to August 2003 set out to examine selected aspects of the impact of the National Numeracy Strategy (NNS) in primary schools. The research used comparable data on Year 4 (pupils aged 8-9 years) pupil attainment and teaching collected for the Leverhulme Numeracy Research Programme in 1997/98 and 2001/02, two years before and two years after the introduction of the NNS. In this paper we report on the following research questions:

- Has children's attainment in numeracy at the start and end of Year 4 improved?
- Have children made more progress than they did previously in Year 4?
- Are there any areas of numeracy in which Year 4 attainment has changed?
- Why have these changes occurred?

DATA COLLECTION AND ANALYSIS

The work drew on: large-scale outcome data on pupil attainment at the beginning and end of the school year of two cohorts of Year 4 pupils (ages 8-9 years) ($n > 1290$ in both cases), from 35 schools, using the same instrument of assessment of numeracy, devised by the King's team; teacher questionnaire data from two sets of Year 4 teachers (1997/8 and 2001/2); observation data of classroom practice from two comparable sets of Year 4 lessons in the same 35 schools; interview data from the two sets of Year 4 teachers elaborating on questionnaire and observation data. During 2003, we revisited five schools and conducted ten interviews with headteachers/mathematics co-ordinators/classroom teachers. These interviews were designed to test the validity of hypotheses developed through earlier analysis. We interrogated the assessment data in terms of overall levels of attainment; gains/losses of different groups within the Year 4 population; areas of mathematics in which

attainment had particularly improved or fallen. Teacher questionnaire and interview responses were compared over the four years. Observation data was perused firstly to identify comparative structural factors of timing and organisation and secondly to compare the detail of classroom interactions.

OUTCOMES

Has children's attainment in numeracy at the start and end of Year 4 improved? Have children made more progress than they did previously in Year 4?

When we compared the test scores for the whole sample for October and June in Year 4 in 1997/8 and in 2001/2 across the period of the implementation of the NNS, we found an average gain in pupils' results (or equivalently in the mean percentage of pupils answering each item correctly) of about 3%. This is the equivalent of just over 2 months' development (see Table 1) and demonstrated an effect size of 0.18.

	October	June
1997/98	52	62
20001/02	55	65
Rise	3	3
Equivalent	2 months	2 months

Table 1. Mean % pupil scores in Leverhulme Year 4 tests before and after the National Numeracy Strategy (Data from same 35 schools with n>1290 pupils for each test)

This difference is highly statistically significant, although probably disappointing to some who expected that the NNS would cause a large increase in attainment. Pupils have made similar progress during Year 4 in both cohorts (1997/8 and 2000/1), with gains of approximately 10% between October and June.

Looking at individual schools' results, about two thirds (66%) of our schools (23 out of 35) had higher results in our tests in 2001/02 than they had in 1997/98; the remaining 34% (12 of the 35 schools) had lower results. Among the schools where results had declined, only 6 of the 12 schools had a decline of more than 2 percentage points in June scores.

Considering how children in different attainment groups performed, we found that the variation in results between the lower and higher attainers had actually increased between June 1998 and June 2002, contrary to the intention of the NNS. Slightly greater improvements were made within the middle 50% of pupils (mean scores 63%:67%), with a small improvement being made within the highest attaining 10% (mean scores 88%:90%), and a small decline within the lowest attaining 10% (mean scores 30%:29%).

Boys appeared to have benefited more than girls from the introduction of the NNS; their scores increased over the four years from 62% to 66%, compared with 61% to

63% for girls. Boys were over-represented in the top 10% of pupils in all four administrations of the test.

Based on the categorisation of eligibility for free school meals, those eligible scored about 10% below those not eligible with a slightly larger gap in 2002 than 1998. However, using the Townsend index of deprivation, it appeared that the most deprived 25% of pupils made greater gains between 1998 and 2002 (56% to 61%) than the least deprived 25% (69% to 71%).

Figures on differences between pupils at different stages of learning English as an additional language and between pupils of different ethnicity were viewed with caution as numbers were small, and categorisations were hard to verify. It appeared that in the categories 'new learners/becoming familiar with English', and 'becoming confident/fluent learners of English' there were larger gains between June 1998 and June 2002 than for the set of pupils with English as a first or only language. There were larger gains in the category 'Indian' than for the whole sample, and a decline in mean percentage scores over the four years in the category 'Black African'.

Are there any areas of numeracy in which Year 4 attainment has changed?

After the introduction of the NNS Year 4 pupils were generally better at answering questions about numbers and the number system (June '98 60%: June 2002 69%); place value, ordering and rounding (64%:69%); mental strategies for addition and subtraction (62%:66%); making decisions about solving addition and subtraction problems (59%:68%); understanding the principles of addition and subtraction in calculations (59%:66%); solving problems about numbers and the number system involving real life, money and measures (54%:59%) and questions about numbers and the number system involving fractions and decimals (47%:50%). Year 4 pupils were generally less good at answering questions about: rapid recall of multiplication and division calculations (80%:78%); solving addition and subtraction problems involving real life, money and measures (60%:59%); making decisions about solving problems involving multiplication and division (57%:48%) and questions involving ratio and proportion (32%:31%).

After the introduction of the NNS in 2002, boys were ahead of girls on all categories of items, except making decisions about solving problems involving addition, subtraction, multiplication and division, where girls marginally outperformed boys. Boys showed a growing dominance in items relating to number and place value.

Why have these changes occurred?

In terms of changes in attainment in different aspects of mathematics, we would suggest curriculum change as having the major impact, with a resulting improvement in pupils' facility on items relating to numbers and the number system and place value. From the Nuffield Mental Calculation project (Askew, Bibby & Hodgen, 2002) it appears that a tendency to focus on addition and subtraction at the expense of multiplication and division may be limiting improvements in the latter area. Pupils'

approaches to real life problem solving and the using and applying of mathematics may also have suffered through a decreased focus on these areas.

Many teachers interviewed in 2002 believed that their pupils were attaining higher standards, with improvements in mental maths being used most frequently to exemplify this. Of the few teachers that were unsure about improved standards, doubts were generally about lower attainers (also suggested by our own results). In 2003, this concern was focused on their ability to participate satisfactorily and confidently in whole class teaching episodes, with a feeling that their needs were not being fully met, although schools were struggling to do this through the use of learning support assistants. Both observation of lessons, especially as part of the case study work, and interviews with children conducted during the Leverhulme Numeracy Research Programme suggest that low attaining pupils derive little benefit from the whole-class teaching episodes, and the topic of the lesson does not always correspond to their areas of greatest need. The result could be that attainment has become further polarised. Some high attainers also expressed to us 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.

In terms of differential attainment between other groups within the pupil population, it is possible that boys have benefited from more whole class work; they feel more confident in participating, and may get asked for contributions more, although we do not have appropriate data to confirm this. Other possible reasons for this difference is that the time spent on individual tasks is shorter than in the past and this may suit boys more than girls. Other differences are less easy to explain. A greater focus on whole class work may help those with English as an additional language by making mathematical vocabulary more explicit and more frequently used. It is worrying that some ethnic groups are doing considerably less well than the general population, but encouraging that social deprivation, while affecting scores obtained, does not seem to affect gains made over time. It may be the case that pupils from deprived backgrounds are benefiting from higher expectations and a more uniform curriculum.

Our analysis of observations noted a move to teachers planning lessons by focusing on objectives rather than activities. While there is merit in sharing objectives with pupils, such a shift of attention is not without difficulties. Firstly, it is not clear whether one should treat NNS objectives as teaching objectives or learning objectives. At issue here is the relationship between 'teaching' and 'understanding'. Understanding is something that develops over time, and specifying it as an outcome of a lesson at the start of a lesson is risky. Despite the apparent specificity of the objectives, teachers still have to do a certain amount of interpretation to put them into practice. As we found in earlier work evaluating the introduction of the National Curriculum (Askew, 1996) teachers interpreted objectives in the light of the existing understandings, rather than changing their understandings.

Although our results support the evidence of structural change brought about through the NNS, our analysis of observation data would replicate the observation of the

OISE evaluation team (Earl et al., 2003), that deep change within the lesson interactions is hard to identify. Our observation data shows limited evidence of what the NNS has recommended in terms of the encouragement of strategic thinking (see also Askew, Bibby & Hodgen, 2002). The NNS stresses the importance of pupils not only developing a 'repertoire' of mental and written calculation strategies from the earliest years but more importantly an ability to select between these according to the size of the numbers and the purposes of the calculation. We have not found an increase of teaching that would promote this strategic thinking. Our analysis of the post-Strategy lessons shows that pupils were provided with more opportunities to explain their methods than they were in lessons before the Strategy. However, there is still some development of these practices needed. We found little evidence, post-Strategy, of pupils actually discussing different methods and looking at strengths and weaknesses of these as they applied to different calculations (for example, when is it more effective to count on rather than count back to carry out a mental subtraction?).

Two reasons may lie behind this lack of discussion of different methods; the first is related to the point above, to the objective-driven nature of lessons. Where the method of calculation to be explored in a lesson was specified in the objective for that lesson, there was little room for teachers to explore alternatives within the lesson. We even observed some teachers going so far as to re-interpret children's explanations so that they fitted with the method being used in the lesson. The second relates to teachers' interpretations of the reasons for introducing a variety of mental methods for calculation. From interview, a popular reason for this change to the curriculum appeared to be that teachers believed that different methods would 'suit' different children and their ways of working. Rather than treat, say, counting on and counting back as alternative methods, the choice between them being made on the nature of the calculation being carried out, instead teachers would teach each in turn, and assume that if children did not understand and use one method then they might be able to do so with the other. It is also possible that teachers were wary of devaluing pupils' responses by making judgements about the relative merits of different methods.

Evidence of teachers focusing more on the means and methods of reaching solutions is encouraging. It is likely that a move to more strategic ways of working is one of the more difficult aspects of the NNS for teachers to firstly understand and secondly implement. As previous research has suggested (Fullan, 2001) the more immediately understandable aspects of a reform are likely to be implemented first; in this case, those of the structure of the lesson, the changes in planning, and the teaching of a range of methods illustrated in the Framework document. Those aspects that can not be accommodated through adapting existing practice or require a deeper understanding of mathematical principles are more difficult to implement and require further professional support. Some headteachers and maths co-ordinators interviewed in 2003 had already identified this move from procedural to strategic ways of working as their next priority for further professional development.

One extremely positive result, we feel, of the NNS is that on-going professional development now has the feel of common practice. One factor that has been of particular importance in this is the role of the numeracy consultant. These professionals seemed to have been able to work successfully with schools with disparate needs, and to maintain a steady, but not overwhelming stream of issues to address, which has encouraged on-going learning. Another is the overwhelmingly positive reaction of teachers to the NNS together with reports of increased confidence and enthusiasm on behalf of both themselves and their pupils. The interviews we carried out in 2003 showed an increased willingness by teachers to make professional judgements in the interests of the needs of their pupils as they perceived them, and to use the Strategy more flexibly. These effects of the NNS should provide a good foundation upon which to engage teachers in professional development that addresses the more challenging aspects of classroom practice.

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