Numeracy Across the Curriculum: Case Study

The Need for a Policy

As head of maths at Deptford Green School in South East London I was responsible for developing and implementing a strategy for numeracy across the curriculum. The impetus for the policy had come from the implementation of a whole school literacy strategy the previous year, led by the head of English and a heritage in the school of middle management led policy development groups. A number of educational factors framed the nature of the developments to come:

- A recognition that the emphasis on numeracy strategies, especially mental numeracy, had changed the way that students were being supported in primary schools, suggested the need for a more consistent approach across the secondary school.
- Worries expressed by other departments, notably science, that students were unable to do some mathematics required by their subject and that these subject teachers were having to teach them the maths.
- Worries in the maths department that students were being taught bad maths in other subjects.
- A desire to develop cross curricula projects in a school which had a very collegiate staff who recognised they didn't collaborate as much as they would like to.

A Numeracy Across the Curriculum Working Group

The first move was to set up a working party. To be effective this had to have the key heads of department i.e. the head of maths and the heads of all those departments where maths was significantly used, plus a member of the senior leadership team to enable policy implementation across the school. We would also have liked the SENCO to be on the group, since the role of support staff working one-to-one or in small groups would have a significant impact on developing numeracy strategies. In the event this proved impossible, which was certainly a weakness. Nonetheless, we were able to get all of the other key personnel involved, which gave the policy the management clout it needed and wide enough representation to ensure implementation at department level where it mattered most.

The working group met fortnightly after school for an hour and set out a range of strategies to be developed:

1. A programme of whole school CPD. Firstly, a staff meeting at the beginning of the Autumn term to launch the policy with a focussed input on numeracy strategies. Secondly an input to a second staff meeting in the Spring Term to review and revisit numeracy strategies and introduce new developments. Finally, an input to a third staff meeting in the Summer term to review and revisit the numeracy aspects of the policy and to share practice.
2. The development of a calculator use policy and shared strategies for supporting students with their mental and written numeracy.
3. The sharing of schemes of work to look at points where key mathematical skills were needed in different subjects and comparing the points at which these would normally be taught in the maths scheme.

4. The production of a booklet to encapsulate good practice in mental and written numeracy strategies and in accurate and 'correct' mathematics, representing an agreement across all of the interested departments.
5. The design of a page for the school planner highlighting key items of accurate mathematics and numeracy as a reference summary for students.
6. A commitment to collaborate across different departments to engage in cross curricula project work.

Inevitably, change in practice across a school is produced by a variety of forces and will always be variable in its impact. Nonetheless, as a group we were able to manage changes in practice in all of the key departments and bring our combined strength to influence practice across the school.

Getting the Maths Department's House in Order

A key starting point for the launch was ensuring that the maths department had its own house in order. Critically, students in primary schools are taught a range of numeracy strategies, which need to be continually practiced. If we look at our year 10 students and moan if they don't know their times tables and then look back and see that we have not ensured that they systematically practice, we cannot be surprised. Naturally they will forget, and the secondary school needs to take responsibility. Famously government ministers have been tripped up by not knowing their times tables, so it isn't simply a matter of learning them in primary school and having them forever. But it isn't just times-tables. Students memorise number bonds and halves and doubles. They need to practice bridging at 10s, 100s etc., decomposition, working to nearest 10s and so on. At the time we had a student teacher on her PGCE who had an essay to write on an area of mathematics, so we suggested that she might look at numeracy strategies. She was a pretty exceptional student, there's no doubt and the outcome was a fantastically detailed taxonomy of different strategies. We used this as the basis of a scheme of work for years 7 and 8 of short starter activities designed to systematically practice the strategies. This followed through into years 9 and 10 with less intensity, but ensured regular practice. This became a key feature of practice in the department and was an enduring success of the whole development.

We also firmed up our policy on calculator usage. Essentially the issue is to recognise that in a mathematics classroom, there is a key responsibility to develop student's facility with number. Hence, a calculator should never be used, unless the numbers to be combined are sufficiently complicated that they could not be combined mentally. We would not expect students to use written methods, unless this was a focus of the lesson. Notably, the move from written numeracy methods for example the grid method for long multiplication, into algebra, would be a circumstance in which written methods would be the focus and naturally a calculator would not be allowed. However, critically, the teacher would decide whether a calculator could be used in a lesson, based on the nature of the numbers involved and the focus of the lesson.

Finally, within the maths department, we needed to agree those aspects of mathematics that we felt were critical features of good mathematics and ensure that we were consistent as a department in developing our student's skills in using them. Initially there was some scepticism that we could be inconsistent, but there was plenty to debate. Good examples would be in the correct writing of fractions e.g. $\frac{3}{7}$ and avoidance of 3/7. This seems trivial, but it is impossible to set out and work on

fractions in algebra with the slanted line, so the 'quotient' format with one number 'over' the other is critical as we go beyond simple arithmetic. Simple but vital is distinguishing an x from an x i.e. a multiplication sign from a letter variable x. In handwriting we always use a curly x and a multiplication symbol has it's lines at right angles $\times$. An agreement to use the European convention of crossing 7's and z's in handwriting avoids the problem that a handwritten 2 and z and a handwritten 7 and 1 are almost indistinguishable.

Naturally, we had other more mathematical issues, like a demand for correctly labelled axes on graphs and the writing of algebra step-by-step with the equals signs in a vertical line and agreement on how we drew and referred to different types of statistical charts. These were discussed, agreed and set out in a document which first appeared in the maths department handbook and was taken for consultation with the whole school working group. Critically, we realised that unless the maths department was consistent in its approach to numeracy, calculators and details of mathematics, then we would never be able to expect colleagues across the school to be so.

The Initial CPD

The initial launch session and numeracy CPD was left to me as head of maths. My essential premise was to design a session which recognised the concern that non-mathematicians have with arithmetic, but to demonstrate to them that without the pressure of memorising the 'correct' method, they were able to be confident with their own arithmetic. This, then provided the mechanism by which they could support students in their own classes. As it turned out, one of the most profound outcomes was members of staff in non-numeracy using departments thanking me for helping them with their own arithmetic!

It is easy to find a nice collection of cartoons on the internet with characters showing their terror of having to do arithmetic. Charles Shultz author of Peanuts was famously a mathsphobic and his characters all appear the same in different strips. This was the starting point for the CPD session to the whole teaching staff in the launch meeting. It really matters to share with colleagues that they are not alone in being nervous about numbers. I then gave them a collection of arithmetic problems to solve in their heads and to consider the method they used. This was really liberating for them to find out that the often labyrinthine methods that they had used are (a) perfectly OK and (b) contain the elements that primary kids are being taught. Basically, the key message is: "If someone is stuck on a number problem, don't tell them how to do it, just encourage them to keep thinking about it". Notably, the message that we need to control the use of calculators, so that we always encourage students to carry on when they could do it in their heads, is manageable. This, in itself has a major impact and stops the situation where a student needs to multiply single digit numbers and immediately reaches for a calculator. This simple achievable aim was another key success of the policy.

Synchronised Schemes of Work

When we sat down with our respective departmental schemes of work, it quickly became clear that the needs of the humanities department to use different statistics and statistical charts and graphs was not a serious timing problem. Slight adjustments were necessary, but the requirements in terms of the complexity of the numbers being used or the types of statistics needed, was entirely within the range of the maths scheme. Significant problems did however arise comparing with the science

syllabus. In science, students must work with straight line graphs early in year 7. This is made harder by the requirements that the graphs are scaled with large ranges and that data points frequently use decimal quantities. Secondly, relationships are expressed as formulae, which students are required to manipulate symbolically, again often with tricky numbers involved.

Especially with the disappearance of the key stage 3 SATs exams, it is clear that there is plenty of scope for give and take in finding solutions to these problems. However, my view as head of maths was that we could be maximally supportive and bite the bullet by working on straight line graphs, right at the beginning of year 7. We needed to take account of the types of values to be plotted and the types of scaling required. This had the added advantage that we were using examples in maths, which were credible to scientists, rather than the usual maths text book examples where everything fits unnaturally well. Students were seeing similar problems framed in similar ways in maths and science at roughly the same time and this was a key feature in supporting them to work on problems that in maths we would have been reluctant to give them at this stage previously. In retrospect, the best solution would have been for the science department to provide the experimental data and for students to use this in their maths lessons, with the maths teacher working on the issues of graphing that data, so that the graph could be returned to the science lesson for discussion and analysis. That would be true cross curriculum working. Sadly, we just couldn't quite co-ordinate our teaching sufficiently to achieve this at the time.

In truth, we were not able to make many changes, but the few that were made had a lasting effect on the ability to collaborate and engage, and gave each department a better insight into what could be achieved. It also, positioned the maths department well for us to be able to say to science and the humanities that we have some key issues of mathematical details that we really care about.

The Good Practice Booklet

In practice the full booklet was developed some time after the initial policy was implemented and may be seen as a final grounding of the work that we did. The booklet is available at www.themathszone.co.uk/Documents/Numeracybookletv3.pdf . The booklet is composed of a number of sections:

1. A very detailed review of mental and written numeracy strategies. By this time our former PGCE student was working in the department and wrote up her analysis of numeracy strategies as a comprehensive guide. This was mainly used by the maths department to frame the policy of numeracy starters. However, it did provide some material for the student planner pages.
2. A detailed guide to written algebra. This was developed from an earlier maths department initiative to clarify how mathematics should be written and was by then an established practice within the maths department. Fundamentally, algebra is the language of mathematics and students need to write it accurately and consistently. We were able to discuss the neat memory devices used in science to help students remember certain formula and ask that in the early stage of learning, students only use correct algebraic expression.
3. A section setting out the detail of terminology and drawing for graphs and statistical charts. We found it was very useful to discuss the details within the maths department and markedly improved our own consistency in doing so. Other departments now had a clear, concise section to refer to, maximising consistency.

Cross Curricula Working

The final component of our development was to increase the level of cross curriculum collaboration. This is not necessarily a part of a policy promoting numeracy across the curriculum, but mathematics is frequently seen as a service subject outside of the maths department (and a powerful and beautiful language within it!) So, it was an excellent opportunity to allow students (and other teachers) to see what could be achieved. The curriculum mapping exercise had allowed colleagues to see areas where we could be working together, but the details of the curriculum specifications meant that we did not find good projects to collaborate on. However, the idea took root and as head of maths I was able to develop a number of projects by exploiting the links that were being made through the working group and the CPD programme.

Two projects that were particularly successful were:

1. Young People Attitudes to Smoking. In the year 9 PSHE programme, we had a series of sessions looking at smoking. The non-threatening environment of the PSHE sessions allowed issues to be raised and discussed. Students prepared questionnaires to generate data about the attitudes of their peers. This work was synchronised with maths lessons, so the design of the questionnaires could be engaged with from a technical perspective, to ensure that a suitable hypothesis had been framed and the outcomes were amenable to analysis. This is often the point of failure in a survey, but working with the maths department meant that effective data was collected. Statistics (percentages and averages) were calculated in maths lessons and suitable charts were chosen and prepared. This was done at a distance from the issue of the problem (i.e. smoking) and therefore not affected by it, simply a technical matter, that could be completed dispassionately in the maths sessions. Back in PSHE the outcomes could be analysed and conclusions drawn. Critically this was done in the context of the problem, which exists within PSHE, so there was animated debate and a clear focus on the issues.
2. Islamic Patterns. The DT Textiles department reacted very positively to my suggestion that students could make Islamic designs as a fabrics project. Again, the work started in the department where the outcomes were to be created. So, the issues of materials, process and the impact of different designs were discussed and planned in textiles. In the maths department we taught students how Islamic designs tessellate the plane (create tiling patterns) using a small number of basic shapes. We took the opportunity to develop the work into an analysis of tessellations in general to see which shapes do and don't tessellate and why. There is a rich tradition in Islamic mathematics analysing tessellation, with a strong interrelationship between religion, architecture/design and mathematics. Naturally, students used the systems and structures they had learned in maths to develop a design, which was created on fabric back in textiles.

Numeracy Across the Curriculum

I have outlined the steps we took at Deptford Green School to implement a policy for numeracy across the curriculum. The existence of a well-represented working group was a fundamental starting point, without which we would have achieved little. That key heads of department were involved in formulating the policy gave them ownership when disseminating within their own

departments. Access to whole school staff meeting time for CPD across the year of implementation was assured with senior leadership representation on the group. This gave the project high visibility and the status of a whole school policy and gave access to all teachers to allow them to develop their views of numeracy. We were able to break down the strong natural negativity by presenting mental numeracy in a supportive way. As the group developed its work, agreements were reached on good mathematics practice and these emerged as documents for teachers and for the students' planners. These were formalised into a comprehensive booklet which acted as a guide to practice. The depth and detail proved especially valuable within the maths department to develop our focus on continuous practice in numeracy. Finally, getting together the schemes of work for the represented departments showed us that a little synchronisation was possible, but that some serious compromises were necessary between maths and science. As lead of the policy it was effective for maths to be maximally accommodating. Also, this process set up sites for collaboration which we exploited with really interesting project work where the expertise of each department was used, complimented and enhanced by the mathematics.

Chris Olley

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