# CONTENTS

# Exploring the Potential for Collaboration across Mathematics and the Humanities

**Ian Davies and Graham Newson**

Department of Educational Studies, University of York

*Collaboration between secondary school teachers of different subjects is undertaken only rarely. This is especially true between subjects that are perceived to have little in common. The potential for collaboration between teachers of two areas which are commonly perceived as sharing little common ground - Mathematics and Humanities - is explored by reference to recent academic and policy related documentation. A description of a joint session undertaken in a University Department of Educational Studies with students who were training to be teachers of either Mathematics, History, Economics or Sociology is given. Small scale data gathering from the PGCE students has allowed for comments to be made about the ways in which subjects are perceived by intending teachers, and to what extent it is felt that collaboration would be worthwhile. Implications for work in schools and for further research are investigated towards the end of the article. It is argued throughout that although collaboration is difficult to achieve, there are many very positive opportunities which could be seized by both intending and experienced teachers, and that in fact there are already some significant examples of such good work which is ongoing.*

## Context

It has long been accepted that teachers in secondary schools of different subject specialisms do not readily collaborate with each other (Lortie 1975; Hargreaves 1991; Blenkin, Edwards and Kelly 1992). Even when subjects which are usually perceived as having similar purposes and methods, such as History and English, there are nevertheless serious difficulties to overcome before soundly based professional work can occur (Bousted and Davies 1992). Whether this is due to conceptions of knowledge, institutionalised management practices, career paths or other factors is not clear, but the result seems clear. It seems likely that the subject-driven National Curriculum which saw cross curricular themes as a late and rather incoherent additrion to the body of work has only perhaps served to add to the difficulties of collaborative work between teachers of different subjects. The impact on schools of these cross-curricular themes was minimal (Purcell 1990) and it seems fairly likely that the Dearing Review will not encourage the DFE or SCAA to promote these themes strongly in the future.

When the particular form of collaboration between teachers of Mathematics and Humanities subjects is considered it is very easy to caricature an unthinking perception of the nature of those areas, as follows:

| **Mathematics** | **Humanities** |
|---|---|
| objective | subjective |
| neutral | biased |
| factual | opinionated |
| useful knowledge | irrelevant |
| high status | low status |
| no risk for teachers | high risk for teachers |
| academically rigourous | lacking in rigour |

The above is, of course, unhelpful to those concerned with the promotion of good

education, and yet it is just that sort of caricature that has led to criticism of those who have tried to forge links. In 1986 (Brown 1986) *The Guardian* reported that Baroness Cox described a CSE examination set by the London Regional Examinations Board for the Secondary Mathematics Individual Learning (Smile) course as 'utterly unacceptable'. The examination was, according to the report, 'intended to relate mathematics to real situations', and included a question requiring calculations to be done which would focus on the relative amounts spent by different government departments. The Examination Board commented that whereas in the past they had always vetted social science papers (eg for political bias) they had never thought it necessary to do so for those involving Mathematics (perceived as a neutral subject). The message for mathematics teachers seemed to be clear: mathematics and the social sciences have little in common and attempts to forge links could even lead to allegations of unprofessional behaviour.

However, there are some more positive signs about the ways in which teachers can make progress. There has been recent research which suggests that the impact of the National Curriculum cannot be thought about in narrow 'traditional' terms (Vulliamy 1992).

Furthermore, there are an increasing number of practice-related publications for teachers which show the sort of work that can be done, with, for example, recent publications focusing on History and mathematical understanding (Copeland 1991), mathematics and political understanding and citizenship (Maxwell 1991; Griffiths 1993). Also important is the way in which recent conceptions of mathematical understanding have been broadened to include an awareness of how the area has been socially constructed. Those in low income countries in particular are focusing on the factors that have led to a concentration on, for example, Arabic numerals and calculations, which are seen as being directly linked to certain dominant modes of thought and action (Frankenstein and Powell 1994). In this sense the scope for collaboration between Mathematics and Humanities is significant.

**Exploring Collaboration with Student-Teachers**

In one session with student-teachers on an Initial Teacher Education PGCE secondary course the potential for collaboration was explored, as described below.

Intending teachers of Mathematics, History, Economics and Sociology were brought together for one jointly planned and taught three hour session in a University Department of Educational Studies during the Summer term of 1994. The students were introduced to what seemed to the session leaders to be the key issues in any consideration of collaborative work between Mathematics and Humanities, and were then invited to undertake three activities. The first asked them to work in small separate groups of either Mathematics students or Humanities students. They were presented with a page from a textbook written for pupils following a GCSE Humanities course on the modern world which included mathematical work. That work asked pupils to consider population growth in different parts of the world. The PGCE students were asked to devise lesson plans in their separate groups, and then discuss the points of similarity and difference between the different specialists. Secondly, they were placed in mixed subject groups and asked to review a curriculum development project (Keyes and Griffiths 1990) which had been written by Mathematics teachers who were aiming specifically to improve pupils' ability to use mathematical understanding in an appreciation of key elements of contemporary society. This review included an opportunity to see a short (15 minutes) video of the project materials in use in classrooms. Thirdly, and finally, students discussed as a full group their thoughts about the nature of knowledge on the context of Mathematics and Humanities: the institutional and wider professional factors which would need to

be considered in any effort at collaboration; and their own feelings about how they would act as a teacher on taking up their first post in the near future.

At the end of the morning session, a questionnaire was distributed to five Mathematics students and five Humanities students. The students were not chosen on the grounds of any rigourous academic sampling, and the issues reported here cannot be regarded as being in any way representative of larger groups. The sample reflected a balance between the sexes, and a rough balance within the Humanities group between Economists, Historians and Sociologists. All students were known to be those who could be relied upon to produce detailed and considered responses, but were not seen as being significantly distinct from the wider group in terms of teaching or academic ability, or perceived attitude towards the course or major professional issues. The responses were analysed first separately and then jointly by the two tutors who had led the session. Students were asked to give comments in five areas: perceived purposes of Mathematics education; the perceived purposes of Humanities education; the perceived overlap between Mathematics and Humanities; the teaching and learning strategies which are felt to be appropriate for developing collaborative work; and, finally, an evaluation of the PGCE session in which the students had taken part.

**Analysis of Responses**

When students considered the purposes of Mathematics education there was general agreement. Three issues were highlighted. Firstly, students focused on the importance of numeracy for everyday life. A very typical response here was:

*"Every pupil should be able to add up, take away, multiply, divide and do percentages. [These] functions are relevant to everyday use. "*

Secondly, students agreed that Mathematics provides skills which are relevant for general problem solving. Many students referred to the view that Mathematics "teaches pupils to think logically". Thirdly, and for a minority of students, the purpose of Mathematics was to provide "a sense of excitement", or "wonder". Here, the notion of doing a subject for its own sake was being perceived by those who may be regarded, possibly and to use crude generalisations, as being less utilitarian and more academic than others.

The perceptions of the purposes of Humanities education again saw much common ground. The value of Humanities for providing a context in which preparing for life can take place was noted. This was seen to occur in two main ways. Firstly, the value of understanding the contemporary world was highlighted. This was stated in such a way as to suggest that there were identifiable, perhaps factual, matters which should be transmitted to pupils. Secondly, there was a belief that critical skills can be developed. Both those ideas were suggested in many responses. For example:

*"To give students a critical understanding of the world in which we live and to provide them with the skills which will enable them to make informed judgements about past, present and future events both on a global and personal scale. [Humanities subjects] give students the tools of analysis by which to address issues and decisions that will arise in their future lives. "*

There were also some students who highlighted the importance of the potential of Humanities subjects to develop less tangible matters. Identity and tolerance were mentioned most often in this area.

When asked about the extent to which the two areas of Mathematics and Humanities

overlap there were very many positive comments. Almost all students strongly endorsed the idea that both areas were fundamentally concerned with developing pupils' skills for future use in a wider context. An analogy with the statistical process can be drawn from the majority of responses. Both areas, it was argued, are concerned with getting information (collection), organising it (representation), making sense of it (interpretation) and communicating it (presentation).

The students, also, had many suggestions to make for the teaching and learning strategies that might be employed in classrooms where teachers aim to develop links between Mathematics and Humanities. The first point that was made by most students concerned the ways in which those teaching and learning strategies could be developed. Many students suggested that co-operation should take place both between individual members of different departments and also on a more formal basis in which departments were encouraged to interact by subject heads and school senior managers. Some of the activities that were deemed to have similar purposes should be promoted: role plays, group work, and simulations were all perceived as being appropriate in both areas. There was a feeling that the content of lessons should be used creatively and dynamically, allowing for historical material, for example, to be used in Mathematics. Similarly, it would be educationally productive to ensure that pupils in Humanities lessons were taught techniques which are traditionally associated with the Mathematics classroom. This is especially true of statistical techniques upon which so many social, political and economic judgements are made.

It was noted by many students that the first exercise based on the Humanities textbook during the joint PGCE session had incorrectly used the term 'matrix', and that pupils would normally be exposed to competing ways of calculating and representing statistical information unless discussion between teachers had led to co-ordinated action. Students were keen to emphasise that initial teacher education had an important role to play in ensuring that teachers had the dispositions as well as the skills for this sort of collaborative work.

Of the ten students who supplied detailed comments, 8 said that the session was extremely useful. Two students felt that the tutors had unreasonably prejudged the level of antipathy between the two groups and so were using the session to set up straw men which could easily be knocked down. The only comments for the tutors to consider for improving this work were to allow students to have more 'hands on' experience by working through pupil materials rather than merely reviewing them, and to spend more time generally as PGCE students working collaboratively with people from other curriculum areas.

## Implications

The very positive responses outlined above are very encouraging. They are also very surprising, in the light of the discussion in the first part of this article which focused on the supposed reluctance or inability of teachers, for personal or institutional reasons, to collaborate with teachers from different subject areas. A number of potentially significant issues are apparent from this work.

Firstly, the positive responses may have been achieved as a result of PGCE students being willing to follow the lead of tutors who argued the benefits of collaboration and showed that practical (although limited) work in schools had, and is, taking place. Students are removed from the day to day pressures of school life which are significant in accentuating both the practical difficulties of co-operation and those cultural factors which mean that teachers Quickly become socialised into institutions which are fragmented and have diverse and at times contradictory aims. It could be argued that the work on the PGCE course has begun to allow teachers to break the

mould of existing practice, or negatively, that the session was an interesting interlude before the reality of the school life made its full impact.

Secondly, and related to the above point, PGCE tutors need carefully to consider their role. Is it the function of those involved in Initial Teacher Education to prepare people for work in existing environments, or to act as some sort of catalyst for change? Very different courses could be developed depending on the response to those alternatives. Further, if the latter option is preferred, it may seem without the benefit of proper research, that tutors are ineffectively promoting worthwhile aims. The need for structured inservice work which follows on from initial teacher education and for the relationship between those different fields of work needs to be further investigated. This point is particularly important in light of the fierce debate that surrounds the recent reforms of initial teacher education. What do those reforms allow tutors to do?

Thirdly, there is, perhaps, a need to make clear the possible difference between the students' relative focus on justifications and purposes. Is it possible for students to respond to a Question about the purposes of Mathematics education by using the sort of educational language (or, to put it more strongly, jargon) that all teachers would recognise, and in doing so their intention is merely to justify the existing position of their own subject. Could, for example, students of different subjects refer to comprehension as a desirable skill to be developed and yet the nature of that skill will be very different in each subject on the school timetable? The meanings that are ascribed to subjects by PGCE students, school pupils and teachers need to be further explored before any real collaborative work can take place.

Fourthly, this work suggests that further analysis should be made of the ways in which school subjects become established. Goodson (1983) has undertaken some work in this area and, given the changes that have been made since the introduction of the National Curriculum, it would seem necessary to examine this issue again. Are subject departments created and developed on the basis of distinctive knowledge, or on their ability to grow within institutional structures? If the latter is important then it is perhaps of little importance that PGCE students or teachers might wish to explore educational dimensions of different subjects.

## Conclusions

This article comments on the very positive responses of intending teachers of Mathematics and Humanities on the issue of the potential for collaboration between their different areas. Although a great deal of further research would be needed before we can be certain, it seems that PGCE students are able to see the overlap between the purposes of the different subjects, and feel confident about how to make collaborative work a reality. The PGCE session which led to the generation of those positive comments was perceived as being successful by students and it may provide an argument for encouraging others to experiment - or, continue - with similar cross subject collaboration. Without collaboration and further research of associated issues, schools and Higher Education Departments of Education seem likely to reinforce the philosophy of discrete subjects which lies behind the recent development of a fragmented, compartmentalised, content-driven and static curriculum (Harrison and Knights 1993). This article has been written with the confidence that the combined professionalism of teachers, tutors, and PGCE student-teachers can resist this pressure and can foster the creation of worthwhile work across the boundaries.

## References

Blenkin, G, Edwards, Kelly, A (1992): *Change and The Curriculum.* London, Paul Chapman Publishing.

Bousted, M. and Davies, I. (1993): Bridge That Gap! Is it Possible To Undertake Collaborative Work in History and English? *Teaching History, no* 71 pp 10-15.

Brown, P. (1986): Row As Maths CSE Examines Arms Spending. *The Guardian* 14 June 1986.

Copeland, T. (1991): *Maths and the Historic Environment.* London, English Heritage.

Frankenstein, M. and Powell, A B. (1994): Towards Liberatory Mathematics: Paulo Freire's Epistemology and Ethnomathematics. In P.L. McLaren and C. Lankshear (eds) *Politics Of Liberation: paths from Freire.* London, Routledge.

Goodson, I. (1983): *School Subjects and Curriculum Change.* London, Croom Helm.

Griffiths, R. (1993): Mathematics. In J. Edwards and K Fogelman (eds) *Developing Citizenship In The Curriculum.*

Hargreaves, A. (1991): Contrived Collegiality: Micropolitics of Teacher Collaboration. In J. Blase (ed): *The Politics Of Life In Schools.* London, Sage.

Harrison, S. and Knights, G. (1993): Cross Curricularity. In J. Edwards and K. Fogelman (eds) *Developing Citizenship in the Curriculum.* London, David Fulton.

Keyes, E. and Griffiths, R. (1990): *Poptrade* Centre for Global Education, University of York.

Lortie, D. (1975): *School Teacher: a Sociological Study* Chicago, University of Chicago Press.

Maxwell, J. (1991) Mathematics. In F. Conley (ed) *Political Understanding Across The Curriculum.* London Politics Ass'n.

Purcell, L. (199?): Letter to Frank Conley. *Grassroots, no 60.* London, Politics Ass'n.

Vulliamy, G. (1992): *The Impact of Global Education INSET.* Paper available from the Department of Educational Studies, University of York.

# Mathematics Teaching from a Different Point of View

**Keith Jones**

University of Southampton

*It has been acknowledged for some considerable time that pupils experience mathematics not only in mathematics lessons but across the curriculum. Teachers, however, seem rarely to get such an opportunity to see and reflect upon how mathematics is taught and learnt across different subject areas. In this article I will relate what a group of non-mathematics secondary PGCE students thought of the mathematics teaching in their placement schools. I conclude that, by experiencing other subjects, not only do the students benefit from a broader perspective on teaching but also that curriculum areas such as mathematics benefit from seeing their subject from a different point of view.*

## Introduction

It is April and a group of 21 student-teachers (secondary) have just returned from a major block of school experience. None of them are undertaking a mathematics PGCE, but all of them are interested enough in the teaching of mathematics to undertake mathematics teaching as a subsidiary subject within their PGCE. This means that in the college-based phases of the course they spend half a day a week looking at the teaching of mathematics and during the school-based phases of the course they may do a little mathematics teaching if this is possible given that they are actually training to teach another subject. At most their experience of mathematics teaching in school will be limited to working with one class.

Through asking these particular students about their experience of mathematics teaching I have been prompted into thinking both about particular issues in the teaching of mathematics and about the current development of the PGCE course to encompass a greater proportion of school-based experience. In this article I will examine some of the cross-curricular aspects of mathematics teaching and argue that it is beneficial for student teachers in any one particular subject to have some idea about what goes on in other subject areas.

## Mathematics Teaching as seen by Non-mathematics Student Teachers

Of the 21 student teachers, the overwhelming majority, 19, are science students. Furthermore the majority of these science students are physics specialists (12). Of the remaining science students six are chemistry specialists and one is a biologist. The remaining two students consist of an English student teacher and a Geographer. Given this mix of student teachers the findings that I will relate below are not meant to be representative in any way. Indeed the make up of the group means that the views of mathematics teaching presented below are predominantly from science PGCE students. Given this proviso, what I intend to do is to use the experience of these student teachers to highlight a number of points which I hope will be of interest to teachers of mathematics and to those involved in their training.

So what was the experience of these students of mathematics teaching during their recent period of school-based work? Below are the results of my asking them about

this:

| | |
|---|---|
| *`Who taught some mathematics?'* | 15 had<br>6 had not |
| *`What are your impressions of the mathematics teaching in your T.P. school?'* | 5 were positive<br>8 were neutral<br>8 were negative |

Although this is a small sample which cannot be said to be representative, even of the views of PGCE students, the proportion of negative impressions is perhaps worrying. These negative impressions were also expressed quite forcibly. Perhaps by looking at the range of replies to this question in terms of students who did or did not teach some mathematics we could throw some light on this divergence of opinion. The distribution of impressions in the categories of positive, neutral and negative for students who had or had not taught mathematics were as follows:

| | **positive** | **neutral** | **negative** |
|---|---|---|---|
| *taught some maths* | 3 | 8 | 4 |
| *did not teach maths* | 2 | 0 | 4 |

The first thing to note here is that those categorised above as not teaching any mathematics did not actually have thje opportunity to spend any time in mathematics lessons. The source of their impressions of mathematics teaching will be made clearer below. The second thing to note is that all those with neutral comments had actually taught some mathematics. In order to throw some light on the other responses, and to make it clearer how I have interpreted and categorised the responses of the students, let us look at the range of comments the students made about mathematics lessons:

| | **positive** | **neutral** | **negative** |
|---|---|---|---|
| *taught some maths* | "well-organised"<br>"interesting approaches" | "ability spread"<br>"pitching the work" | "chaotic"<br>"low concentration time"<br>"problems with scale, number skills, manipulating formulae" |
| *did not teach maths* | "good contact between depts"<br>"maths not a problem" | | "problems with line graphs, units, pie charts, rearranging formulae" |

## Some Observations

1. A number of the student comments quoted above relate directly to the student's personal experience and the views that they hold of how teaching ought to be done. Well-organised lessons and the chance for them to experience interesting teaching approaches perhaps inevitably leads to more positive comments than mathematics lessons that may appear to be chaotic. It is open to question just what they meant by 'well-organised' or 'chaotic'.

2. Good contact between departments and the impression that the pupils have met the mathematics they are to need in other subject areas, particularly the student's own

subject area, can also, it seems, lead to more positive comments whether you taught mathematics or not. Whether the students view mathematics solely as a service subject is also something that is open to question.

3. Of the student teachers with what I have classified as 'neutral' impressions, their concerns are what can be called professional concerns. These students did not express any negative views. What they are doing is recognising some of the major issues in the teaching of mathematics such as the range of attainment apparent in any class and the difficulty in preparing appropriate work.

4. The negative comments focus more on particular areas of the mathematics curriculum and its intersection with other school subjects. Drawing graphs and manipulating formulae arose as issues both for those who had and for those who had not taught some mathematics. The negative comments specifically from those students who did not have the opportunity to teach any mathematics are primarily about how the pupils the student did teach in their own subject area did not have the mathematics skills that the student teacher thought they should have. I will return to this particular point below.

A possible conclusion based on this evidence is that even if students are not training to be mathematics teachers then some experience of being in mathematics lessons with perhaps some form of teaching responsibility may help to focus the student's attention on issues in the teaching of mathematics rather than exacerbating the potential conflicts between different subject departments. It is to these issues of potential conflict that I turn to next.

## Mathematics across the Curriculum

It goes without saying that pupils experience mathematics across the curriculum. Unfortunately it is frequently the teachers who do not. Now, of course, this issue is not new and strenuous attempts have been made to overcome this problem over many years (see, for instance Breslich 1936). However, the problems still remain. The National Curriculum Council (1991), for instance, have reported on a number of case studies carried out mainly to evaluate the implementation of the National Curriculum but which illustrate the problems with cross-subject collaboration and the growing impetus to make it more effective. Amongst the problems highlighted are (perhaps un surprisingly) timetabling issues, major differences in teaching methods between departments and territorial claims for particular aspects of the curriculum. On the other hand the NCC reports the impetus for more cross-curricular planning as coming specifically from heads of mathematics and science departments. This impetus, the NCC claims, comes not from a concern to plan for the five cross-curricular themes of the National Curriculum but more from the growing awareness of the need to coordinate more effectively the teaching of mathematical or scientific knowledge, skills and processes in other subjects

Indeed many attempts have been made to co-ordinate work across subject departments in secondary schools but the problems do not seem to go away. For example, Hammond (1993) found when he tried to instigate cross-eurricular work that "schools do not teach topics they teach subjects". Furthermore he found that setting and option choices often made it quite unlikely that the same pupils were together in different subjects. As a result, while he found that there are schools that successfully carry out some cross-eurricular work, Hammond found it more useful to look for and work with cross-curricular skills solely within a particular subject area.

It is a salutary experience to reflect that the very mathematical topics that my students raised as problems with mathematics teaching during their school experience, that is scale, number skills, line graphs, units, pie charts and rearranging formulae, are amongst the very issues raised by a Schools Council report published in 1984 (Denyer 1984) which itself echoes similar concerns expressed by Bausor in 1974 (Bausor 1974). As I remarked above, these concerns are not new yet you would expect that, over time, some progress would be made. In an undated report from the mid-1970s a joint committee for physics education of the Royal Society and the Institute of Physics into the relationship between mathematics and physics concludes that:

*In future revisions of mathematics syllabuses it is to be hoped that consideration would be given to the requirements in terms of content and timing of subjects using mathematics such as the sciences, geography, craft and technical drawing. We recommend that wherever possible there should be direct consultation between the interested paTties.*

(Joint Committee for Physics Education, undated p 4)

The implementation of the National Curriculum has been, of course, an ideal opportunity to implement this recommendation. The evidence to date, however, is of an emphasis on individual subjects and little sign of this recommended consultation between these subjects. Even the Ofsted reports on the implementation of the mathematics National Curriculum make virtually no mention of mathematics across the curriculum. So if there is little support to be found in current curricular documentation, is there a role for teacher education?

## Teacher Education

The Government sees the training of teachers as an important component in the drive to 'raise standards' in schools (DfE 1994). It could be that conflicts between subject departments in schools over the teaching of mathematics may deflect energy from the important task of raising levels of achievement in mathematics. It may be helpful for initial training programmes to give secondary mathematics student-teachers appropriate experiences to increase their understanding both of how mathematics is learnt and taught in mathematics lessons and of how it is learnt and taught in other subjects. Useful questions to ask about course designs for mathematics student-teachers include:

- Do the students have opportunities to see how mathematics is learnt and taught in other subjects?
- Do they have the opportunity of seeing practising teachers collaborate across subject areas?
- Is there an expectation that the students attempt some cross-curricular work in collaboration with another subject area?
- Are the students introduced to appropriate curriculum

materials?

For student-teachers in other subject areas such as science, geography and technology it may also be worthwhile for them to have the opportunity to experience and reflect upon the teaching and learning of mathematics both as it happens in their own subject as well as in mathematics lessons and even perhaps more widely across the curriculum. If these are agreed to be important components in the initial training

of secondary teachers then the next issue to be addressed concerns practical course design. Just what mechanisms can be used to help students get a broader perspective on the teaching of their own subject from seeing it through the eyes of a student teacher from another subject area.

At my institution we have, for some time, collaborated with colleagues in science and presented one or two joints session for mathematics and science student teachers. We also encourage students to spend some time in other subject lessons during their time in school. This is a small beginning which, given the constraints under which we are working, we would like to build on

in a more systematic way. On the wider front of secondary initial education, it could well be that the problems raised in the previous section regarding timetabling issues, major differences in teaching methods between departments and territorial claims for particular aspects of the curriculum are not peculiar to schools. They may well surface in initial training institutions, albeit in slightly different forms. There may also be additional issues particular to initial teacher education courses. The danger then is that initial teacher education serves only to reproduce subject conflicts rather than work with subject differences in a constructive way.

## Conclusion

The move to a more school-based form of initial teacher education has with it the possibility that has always existed with the schoolbased element and which has been recognised by many of those concerned, that this education can consist mainly of being socialised into the particular school in which the student is placed. A further possibility is that this socialisation, is, moreover, into the student's own subject department. Without appropriate experiences for student teachers the conflicts which can arise between departments may only serve to repeat themselves. As the report 'Better Mathematics' says so emphatically:

*Most of the problems encountered in working across the curriculum are due to, and exacerbated by, the enormous lack of awareness that exists in schools about what everyone else is doing, and about the nature of different subjects. This is especially true of mathematics where strange preconceptions are rife.*

(Ahmed 1987 p 58)

Perhaps initial teacher education can provide a small move in the right direction of overcoming preconceptions and improving student teacher awareness of the nature of school subjects, including a wider perspective on their own subject. The students that I have worked with, through their experience of what goes on in mathematics lessons, have begun to have some understanding of the issues involved in teaching mathematics. I have also learned from seeing mathematics teaching from a different point of view.

## References

Ahmed, A (1987), *Better Mathematics: a curriculum development study.* London: HMSO.

Bausor, J (1974), 'Mathematics and Science: uneasy truce or open hostilities. *Mathematics Teaching.* September, 32-41.

Breslich, E (1936), 'Integration of Secondary School Mathematics and Science', *School Science and Mathematics,* 36, 58-67.

Denyer, J (1984), *Mathematics Across the Curriculum.* London: Schools Council.

Department for Education (1994), *Citizen's Charter for Education. 2nd Edition.* London: DfE.

Hammond, M (1993), 'What does Cross-curricular Mean?' *Mathematics in Schools,* March, 14-15.

Joint Committee for Physics Education, Royal Society and the Institute of Physics (undated report, mid-1970s), *The Relationship between Mathematics and Physics between the ages of* 11 *and* 16. London: Institute of Physics.

National Curriculum Council (1991), *National Curriculum Evaluation.* York: NCC.

# A Survey of Secondary Mathematics Initial Teacher Training

Derek Haylock

School of Education, UEA Norwich

*This report is the result of a survey of Higher Education (HE) institutions in England and Wales providing initial teacher training (ITT) for secondary mathematics through the Postgraduate Certificate in Education (PGCE) route, carried out in May* 1994 *on behalf of the Joint Mathematical Council of the United Kingdom. The survey was prompted by reports that some institutions were having difficulty in securing places for secondary students within the new partnership arrangements associated with Department for Education Circular 9/92. The results of the survey suggest that HE institutions generally are succeeding in making the new arrangements work and there is no special problem related to mathematics placements. However there are localised problems in finding sufficient good-quality placements. A number of compromises are reported and there are indications of some reluctance on the part of some schools to take on the extra responsibilities of a partnership programme of initial training.*

## The Survey

Questionnaires were sent to 54 institutions listed in the Graduate Teacher Training Registry handbook as providing secondary PGCE mathematics courses in 1993-94. Replies were received from 38 (70%) of them. A number of those who did not respond were taking secondary mathematics students for the first time in 1993 and would therefore be unable to make the comparisons requested in the survey.

## Difficulty in Securing Placements for Secondary Mathematics

First of all the questionnire asked PGCE tutors in HE institutions to respond to the following question:

*Compared to previous years (i.e. before implementation of* 9/92) *to what extent have you experienced difficulty in finding sufficient placements for secondary mathematics students in the current year* 93-94? *To what extent are you experiencing difficulty in finding sufficient placements for secondary mathematics lTT students for next year* 94-95?

The numbers of institutions indicating various levels of difficulty are given in the following table:

| **Difficulty in securing placements** | **1993-94** | **1994-95** |
|---|---|---|
| No more difficult than in previous years | 21 (55%) | 17 (45%) |
| More difficult | 11 (29%) | 12 (32%) |
| Considerably more difficult | 5 (13%) | 4 (11%) |
| Unable to make a comparison | 1 ( 3%) | 5 (13%) |
| Enough places only by making compromises in our partnership scheme | 10 (26%) | 9 (24%) |

Clearly there is a significant proportion of HE institutions who are finding some increased difficulty in securing teaching practice placements following the implementation of circular 9/92. These institutions are not randomly spread around the country. It is clear from the returns that there are specific areas where the difficulties are concentrated, notably around the Greater London area and in a few other major cities.

The higher number unable to make a comparison for 1994-95 with previous years was related to the timing of the survey: several institutions indicated that they were still in the process of contacting schools and were not yet in a position to comment on how difficult it would prove to be.

Respondents were asked to indicate the kinds of compromises which they were having to make in order to find sufficient places. The compromises most often cited were in terms of failure to find enough schools of the right kind, with appropriate strength and experience in the mathematics department to enter fully into the partnership arrangement. This has led to using schools not involved in the partnership and associated 'mentor training' and some reversion to former models oftraining:

- *having to make placements outside of the partnership (several statements like this)*
- *the pool of schools available was restricted to those where mentors had been trained, often not those used in the past and not those best suited to student needs*
- *not getting first choice mentors because partnership is agreed at senior management level, regardless of the track record of the maths department*
- *we had to put students in schools which have not been involved in mentor development sessions*
- *placing students in the independent sector - not our normal practice*
- *less input from school staff than planned in our partnership scheme and more support by College staff*
- *alteration of numbers and / or subject balances within partnership schools to fit requirements*
- *we had to accept understaffed and under-resourced schools with no mentoring skills as the only means of placing students*
- *less than full partnership for some schools being proposed: roles of college and school reverting to old model (although not in terms of time available)*

Other compromises recorded were:

- *we had to pay over the odds for the last four places*
- *lower proportion of maths teaching on students' timetables than we wanted*

• *mainly logistics - eg more travel for students*

There is a clear sense in these responses that for a significant number of institutions the challenge of making partnership schemes work is, at the least, causing considerable administrative burden and in some cases is proving to be impossible simply in terms of securing the right kind of school placements with the required level of commitment to the partnership schemes.

## Quality of placements

Tutors were asked to compare with previous years, on average, the quality of experience, training and support for students provided by the placements secured this year, and similarly their expectations about the placements secured for next year.

The responses were:

| **Quality of experience compared with pre-9/92** | **1993-94** | **1994-95** |
|---|---|---|
| *About the same* | 27 (71%) | 13 (34%) |
| *Lower* | 2 ( 5%) | 3 ( 8%) |
| *Higher* | 6 (16%) | 9 (24%) |
| *Unable to make a comparison* | 3 ( 8%) | 13 (34%) |

These responses indicate that on the whole tutors are satisfied with the quality of the placements being secured for their students, with a significant number indicating that the quality of the experience provided by the schools is higher. In almost every case this was related to the opportunities provided by the move to partnership for some form of professional development for the teachers with responsibility for students (i.e. 'mentor training'). These responses may seem inconsistent with the earlier statements about compromises. A possible explanation here might be the reluctance of HE institutions in the age of quality assessment and OFSTED inspections publicly to concede that any aspect of the quality of their provision is lower than it might have been previously.

## Comparison of Mathematics with

## Secondary Students in General

Tutors were asked to compare for the current year, 1993-94, and next year, 1994-95, the level of difficulty in placing mathematics students with placing secondary students in general.

The responses were as follows:

| **Level of Difficulty** | **1993-4** | **1994-5** |
|---|---|---|
| More difficult to find sufficient satisfactory places for maths | 6 (16%) | 5 (13%) |
| Less difficult to find sufficient satisfactory places for maths | 8 (21%) | 7 (18%) |
| About the same | 22 (58%) | 21 (55%) |
| Unable to make a comparison | 2 ( 5%) | 2 ( 5%) |

It appears that there is no evidence here for mathematics placements being any more or less difficult to secure than other subjects, overall. Comments written on the response forms suggest that those who are finding mathematics students more difficult to place have had recent increases in numbers of mathematics students; other indicated that the subject causing most difficulties is science.

## Reasons for Difficulties in Securing Sufficient Placements

Finally, tutors were asked: *if your institution is experiencing some difficulty in securing sufficient placements, either this year or next, what in your experience are the reasons?* A number of possible reasons were offered on the questionnaire, with space for others to be added. The responses were as follows:

| **Reason given for difficulty** | **Frequency** |
|---|---|
| *reluctance in the schools to take on the extra responsibilities of 'mentoring' required within the new partnership arrangements* | 19 (50%) |
| *unwillingness to cooperate with what is perceived as yet another government initiative* | 14 (37%) |
| *the 'transfer of resources' to schools (payment etc) is insufficient* | 22 (58%) |
| *competition from other ITT institutions* | 14 (37%) |
| *some schools involved in developing school-provided ITT schemes* | 2 ( 5%) |
| Reasons not offered on the questionnaire but which were suggested by tutors included: | |
| *reluctance of partnership schools to take many students at a time* | 3 ( 8%) |
| *concern about parents' reactions to children being taught by students* | 1 ( 3%) |
| *schools just too busy with other matters* | 1 ( 3%) |
| *concern about effect of too many students on quality of teaching* | 1 ( 3%) |
| *schools have other priorities, especially teaching children* | 1 ( 3%) |

These responses confirm an impression that some tutors perceive a fair degree of reluctance in some schools to enter into the new partnership arrangements, with the extra responsibilities implied, and that there is an associated dissatisfaction with the level of payment which institutions are able to offer in recognition of the extra load being borne by the schools. In a world where market models are now being applied to education, there is also some significance in the extent to which competition from other initial teacher training institutions is now perceived to contribute to the difficulties of securing placements for students (37% indicated this), although as yet there appears to be minimal loss of school placements to SCITT (school-centred initial teacher training) schemes.

# Breaking the Chains of the Publlshed Scheme

**Steve Mills and David Harries Faculty of Education and Community Studies**

University of Reading

*This paper outlines a model for use in developing plans for pupils' work in mathematics. It is introduced to all students who are on primary initial teacher education courses at our institution with the intention of helping these students to engage confidently with the teaching of mathematics, rather than simply to manage the children's individual progress through a commercially-produced mathematics scheme .... The model encourages the student-teacher to focus on three obvious, but often-neglected, aspects of planning: (i) to analyse the mathematics to be learnt, (ii) to find out where the children are in their understanding of this mathematics, and aU) to select and prepare appropriate activities and a range of teaching approaches.*

## The Problem

In 1989 HMI concluded from their inspection review that:

*"There was little evidence to suggest that heavy reliance on routine sessions of mathematics based on textbooks and published workcards resulted in the most effective learning"* (HMI, 1989)

Two years later, they added:

*"Most schools relied too heavily on commercial mathematics schemes which were used in a largely undifferentiated way"* (HMI,1991).

Our own experiences as teacher educators in the field of primary mathematics suggest that many primary-school teachers do rely heavily on commercial schemes, occasionally at the expense of all else, and that, in many cases, the quality of mathematical learning which results is somewhat questionable. Tony Wing puts the effects of this approach into sharp focus in describing the typical primary mathematics classroom scenario:

*"Most often in classrooms I see children travelling through their workbooks in a private way, sometimes racing, sometimes dawdling in the hope that it will soon be playtime, but mostly accepting that this is how mathematics is done. Teachers' notes are usually some way away, on a staffroom shelf. Workbooks and their pages are fulfilling the same kind of function as graded reading books, and they enjoy a similar status; their authority is absolute, their content defines mathematical performance, and they are wonderful for dealing with troublesome parents. I see almost everyone's confidence rise when it is time to do sums; we all know where we stand in relation to sums."* (Wing, 1986)

If our current student-teachers are not to join the ranks of those who operate in this way it is essential that they experience alternative models of mathematics teaching and learning which allow them to treat the commercial mathematics scheme as a resource, amongst other resources, to be used when appropriate. For many students, armed only with a distant pass at GCSE and little real understanding of mathematical ideas, such an approach can be daunting. It is, however, perhaps these students above all others who, at this stage in their careers, need to experience and develop confidence in ways of working that do not automatically involve turning to the next

page of the scheme. Such approaches are central to furthering their professional development.

It is in an attempt to respond to this need that colleagues in the field of primary mathematics education at Reading have developed a model of teaching and learning which offers an alternative approach and which permeates the mathematics courses of our primary BA (Ed) and PGCE students.

A Model for Planning to Teach Mathematics Mathematics Curriculum courses, taken by all students, include time for developing schemes of work for use in school, at which point the following three-stage model is introduced. It draws on a range of work, particularly from the Cockcroft Report (Cockcroft, 1982), Mathematics from 5 to 16 (HMI, 1985) and the National Curriculum non-statutory guidance (NCC, 1991).
Whatever mathematical topic is to be taught to whatever group of children, the following three aspects of planning have to be considered:

(i) Analysing what has to be learnt in the topic
(ii) Finding out where the pupils are in their understanding of the topic
(iii) Selecting and preparing activities which embody a progression of ideas and which utilise a range of teaching approaches.

**Analysing the Topic**

Students are encouraged to start thinking about the topic they are about to teach by considering the learning outcomes they intend to achieve. They are encouraged to ask:

*"In the learning of the topic what are the important things for children:*

- *to know (facts)?*
- *to know how to do (skills)?*
- *to understand (conceptual structures)? • to use and to apply (processes)?"*

Opportunities are presented for students to work in groups to research the topic and to draw up a response to the above questions. They are encouraged to consult a wide range of sources, including maths education texts (such as Dickson *et al, 1984;* Williams and Shuard, 1970; and Liebeck, 1984). The National Curriculum programmes of study are referred to, as are teachers' handbooks from commercial schemes.

As their knowledge of the topic is developing, students are helped to reflect upon the ideas in terms of the categories given above. The ability to consider their ideas in terms of facts, skills and concepts is important in their developing understanding of the nature of mathematics. A questionnaire-based evaluation of this part of the course, undertaken after a school experience by second year BA(Ed) students, elicited a series of encouraging responses from students, many of which echoed the following:

*"Has given me the confidence to look critically at children's learning"*

*"Has helped me to recognise the needs of children when learning maths"*

*"It has given me much more idea about how to approach the teaching of maths"*

In addition, this focus on subject knowledge caused a number of students to feel they were in a position to

*"anticipate misconceptions that might occur and to know what [could do about them"*

The teachers who hosted these students were also asked to provide feedback. Given that these students are only in their second year, many teachers felt there was clear direction shown in their planning and teaching, with one teacher commenting:

"[ *was pleased to see a sense of purpose and structure*

*behind the activities"*

Over 90% of the teachers who responded graded the students' ability to identify clear mathematical objectives as 'good' or 'very good',

**Finding Out Where the Pupils are in Their Understanding** Alongside their developing knowledge and understanding of the topic to be taught, the student's attention is now directed towards establishing as much information as possible about the children's current knowledge and understanding in that particular topic.

The crucial nature of this aspect of planning is underlined

strongly by the educational psychologist, David Ausubel:

*"If I had to reduce all of educational psychology to just one principle, I would say this: the single most important factor influencing learning is what the learner already knows. Ascertain this and teach him (sic) accordingly."* (Ausubel, 1968)

Having established the fundamental principles of the topic, it is essential that students turn their attention to asking similar questions of the children they are to teach. What do the children know, know how to do and understand about the topic at the present time? The second stage of our planning process is concerned with two things: establishing the need to find this out and exploring the ways in which we might do so. Out students are encouraged, during the series of prior visits made to the schools in which they are to undertake their school experience, to do and reflect upon the following:

- Refer to any commercial scheme books used by the children to see the work they have previously met in the topic, and look at their workbooks to see what they made of it
- Look at both formative and summative records for further information
- Ask the host teacher for information about previous work done
- Talk informally to the children, asking questions devised from a developing understanding of the nature of the topic
- Use this knowledge to devise further diagnostic material.

This might be in the form of a worksheet, a series of oral questions, a game or perhaps a combination of these

On their return from a period in school, many students commented that they had paid insufficient attention to this aspect of the work. As a result several experienced

planning problems including mismatches and lack of extension materials for pupils. This experience, for these students, has no doubt helped them to realise the importance of attending to this more carefully in future. Others were already convinced, commenting that such work was "time really well spent."

**Preparing Activities and Teaching Approaches**

The planning task of the students now is to select and prepare activities which embody a progression of ideas and which utilise a range of teaching approaches.

Informal observation suggest that many students, faced with preparing a teaching scheme for area, decimals, length etc, too readily begin the task by searching for activities they might use, with insufficient regard for either a progression of appropriate mathematical ideas or for the levels of understanding their children possess. It is vital that attention has been given to these first two stages of the planning process. Once this has been done we need to ask where we can find information on appropriate activities, suitable materials and meaningful progression.

Once again a variety of teachers handbooks are consulted for their suggestions of activities, progression and purpose. Maths education texts examined when getting to know the topic are revisited, together with a whole range of books and periodicals in our Mathematics Resource Room.

As the range of activities which embody the knowledge, skills and understanding which has been identified as being central to the mathematical topic begins to take shape, we turn our attention to the range of approaches we might adopt to teach these.

- Are we giving children opportunities for discussion, practical work and problem solving in the work they are to do?
- Are they engaged in investigative work, and do they have

opportunities for practice and consolidation?

Such questions, covering the approaches outlined in Cockcroft paragraph 243 (Cockcroft, 1982) are asked about the developing scheme of work.

Finally we raise the issue of the Mathematics Attainment Target 1, by asking students to identify strategies or processes which the activities give the children opportunity to use and develop. For example:

- Are there any activities which call for trial and error or the ability to simplify and to be systematic?
- Could an activity be modified to give the children an opportunity to devise their own recording system?

**Conclusion**

Such an approach as this asks a great deal of students and of nonspecialist mathematicians in particular. It is an approach which is developed and revisited over the duration of the students' course, benefiting from, and adding to, their experiences in working with children. It is our experience that students who work in this way are more able to appreciate the links between areas of mathematics, and, importantly, its cross-curricular potential. In addition, questions which focus on how we might assess pupils’ progress in mathematics are more meaningfully considered because students

have a firmer grasp of the nature of learning outcomes.

The recent Government Circular concerning initial teacher education (DFE, 1993) states that improving teachers' knowledge of the students they teach is a priority. Clearly, a lack of subject knowledge must be a contributory factor in ineffectual teaching. It would seem that that an over-reliance on commercial schemes, as underlined by the comments of HMI, is related to primary-school teachers' insecurity with the subject and does nothing to increase their own knowledge and confidence in mathematics. If this is the case, it is essential that alternative approaches to mathematics teaching and learning are explored. To this end, we would suggest that an approach which has knowledge of the topic in question is a cornerstone, together with an appreciation of where children are in their understanding of it, may serve to promote more effective learning in mathematics than might otherwise be the case if we rely too heavily on children working their way individually through a series of commercial textbooks.

## References

HMI (1989) *The Teaching and Learning of Mathematics* London: HMSO

HMI (1991) *Mathematics: Key Stages* 1 *and* 3 London: HMSO Wing, T (1986) 'A Problem With CATE' , *Mathematics Teaching June 1986*

Cockcroft,W.H. (Chairman) (1982) *Mathematics Counts* London: HMSO

HMI (1985) *Mathematics from* 5 *to* 16 London: HMSO

National Curriculum Council (1991) *Mathematics in the National Curriculum: non-statutory guidance* London: HMSO

Dickson, L. *et al* (1984) *Children Learning Mathematics* Cassell Williams, E. and Shuard, H. (1970) *Primary Mathematics Today* Longman

Liebeck, P. (1984) *How Children Learn Mathematics* Penguin Ausubel, D. (1968) *Educational Psychology: A Cognitive View* Holt, Rinehart and Winston

DFE (1993) *Circular* 14/93 *The Initial Teacher Training of Primary School Teachers; New Criteria for Courses* London: HMSO



**Original pagination of this article – pp25-30**

# The AMET Response to the Dearing Review of the National Curriculum

**Derek Haylock**

School of Education, UEA Norwich

on behalf of the Association of Mathematics Education Teachers

*In May* 1994, *as part of the Dearing Review of the National Curriculum, the Schools Curriculum and Assessment Authority published its draft proposals for the revision of the mathematics curriculum (Schools Curriculum and Assessment Authority, 1994). This is the AMET response to these proposals, submitted to SCAA in July* 1994. *It was prepared by the Chair following consultation with other members of the AMET committee.*

## Introduction

The Association of Mathematics Education Teachers represents those who work in mathematics education teaching and research in higher education. We congratulate the mathematics review committee on what they have achieved in the short time available. We welcome the opportunity to respond to these draft proposals and hope that our comments will be of constructive help in the preparation of the final Order for mathematics. Since our comments do not easily fit into the format of the response form we are submitting this paper.

## The Structure of the Draft Order

We ,welcome the new structure with its emphasis on programmes of study which can be used by teachers to plan their work with children. A curriculum based on programmes of study rather than on an assessment framework is much more appropriate than the earlier versions.

It would be unfortunate if, as a result of habits acquired in earlier versions of the National Curriculum, teachers were misled into using the level descriptions for planning, particularly since these do not purport to be comprehensive in nature. It is important therefore to emphasise as strongly as possible that the basic planning tool is the programme of study and that the level descriptions are for summative assessment only.

It also important that SCAA should ensure that requirements for assessment of pupils do not undermine the implementation of the full range of the mathematics National Curriculum by encouraging a teaching style which focuses exclusively on preparing pupils for the limited content of externally-imposed national tests.

The Introductory Paragraphs for Attainment Targets The introductory paragraphs for each attainment target have the potential for influencing the teaching of mathematics very positively in the direction of what we recognise as good practice. It is important therefore to emphasise in some way that these have as much weight as the subsequent bullet points. It might be possible, for example, also to set these paragraphs out as a series of bullet points. It would be particularly helpful for the

important principles contained here to be numbered or lettered, so that they can be referred to simply and systematically in planning and evaluating mathematics teaching in schools.

## Attainment Target 1 and the Appendix

This association is strongly in support of the proposal in the body of the report that 'Using and Applying Mathematics' should be retained as a separate attainment target. We are therefore opposed to the the alternative proposed in the appendix.

A number of reasons can be put forward in support of this position:

- *the central importance of the processes highlighted in this attainment target in mathematics*
- *comparability with the Science Order*
- *the notion that using and applying mathematics is at the heart of basic numeracy*
- *that using and applying mathematics often calls upon mathematical skills and knowledge from* a *range of content areas*
- *the importance of ensuring* a *balance between process and content*
- *the need to ensure progression in this aspect of mathematics*
- *that having this as a separate attainment target will ensure that teachers do not sideline this aspect of mathematics in their teaching and assessment of pupils*

There is, of course, a historical and political context to this issue which cannot be ignored.

This goes back to the original proposal for a separate *'profile component three'* (Department of Education and ScienceIWelsh Office, August 1988) which was supported by a huge majority of those who were consulted (National Curriculum Council, December 1988) but rejected by the Secretary of State at the time.

The revision of the Mathematics Order in 1991 into five attainment targets (Department of Education and ScienceIWelsh Office, 1991) with *Using and Applying* as the first of these, effectively restored what the majority of the mathematics education community had pressed for originally.

As a consequence of this Order many teachers have begun to modify their approaches to teaching and assessment in mathematics in order to provide more opportunities for pupils to use mathematics to solve real problems, in practical tasks, and in discovering new mathematics for themselves.

With this background, to implement the proposal in the appendix would be to send out a signal to these teachers that using and applying mathematics is not as important as had been suggested and that they can revert to their former practice. This would be most unfortunate.

## The Content of AT1

The mathematical language strand of this attainment target is numbered as section 1 in Key Stages 1 and 2, but numbered as section 2 in Key Stages 3 and 4. This is presumably an error in presentation.

Calling this section 'Developing Mathematical Language' in Key Stages 1 and 2, rather than 'Communicating Mathematically' as in Key Stages 3 and 4, weakens the

attainment target considerably, since 'developing' is not 'using and applying'. Furthermore, many aspects of developing mathematical language are covered elsewhere.

### The Range of Mathematical Ability

The programmes of study do not really face up to the issue of the range of mathematical competence which will be encountered in a Key Stage and how teachers might tackle the issue of differentiation in their planning.

In Key Stage 1 the content includes most of levels 1, 2 and 3 from the 1991 Order. As a result, especially in the number target, much of the programme of study will be inappropriate for many average and below average pupils. The danger is that teachers will interpret the programme of study as a requirement to teach all that is there to all pupils. This would be disastrous for many lowattaining pupils.

Here and there in the programmes of study there are hints in the language used that not all pupils might deal with all the material. At least three phrases are used: 'leading towards', extending to', 'progressing to'. One solution therefore would be to use a consistent phrase and make it clear that when, say, 'extending to' is used then there is an expectation that this material might not apply to all pupils.

It might be better, however, to set out the programme of study with one section which clearly relates to material that might be encountered by 'most average pupils', and then have a separate 'extension' section, as is used in Key Stages 3 and 4. At least this would send out a clear message for the need for differentiation in planning.

## Algebra

We are unhappy about the decision to delete algebra from Key Stages 1 and 2 and to combine algebra and arithmetic into one attainment target for Key Stages 3 and 4. The only logic behind this appears to be that the amount of arithmetic content gradually decreases through the levels, as the amount of algebraic content increases, so it is convenient in terms of organising words on paper to put the two together.

It is a naive view of algebra to regard it as simply 'using letters for numbers'. The development of the idea of algebraic letters as representing variables which allow you to formulate generalisations should be seen as a discrete pedagogical issue. Since research has clearly indicated that the characteristic processes of arithmetic actually interfere with the development of algebraic thinking, it is somewhat bizarre to tie them together so closely in the National Curriculum.

The structure of the present proposal also undermines the potential for teachers to begin the process of the development of genuine algebraic thinking in Key Stages 1 and 2. Certainly the more able pupils in Key Stage 3 are likely to be denied the opportunity to engage in appropriate mathematical activity given the present structure.

The 'developing mathematical reasoning' section of AT1 at Key Stage 2 would be potentially so much more fertile for the more able pupils if it were to be supported by some recognition of algebraic content in the rest ofthe programme of study.

If the decision is to retain the single attainment target then at least let us retain the heading "Number and Algebra" throughout all Key Stages.

It is inconsistent that some algebra (formulae and linear functions) appears in the Level 5 description, but does not occur in the Key Stage 2 programme of study.

**Levels and Level Descriptions**

We are happy with the notion of level descriptions, rather than the bogus precision implied by the former assessment structure of statements of attainment.

Under the present Order there is an understanding that Key Stage 2 work in mathematics should include material up to level 6, to recognise that some more able pupils will achieve this level. In the new proposal, the Key Stage 2 programme of study covers only up to level 5, although the level descriptions provided for assessment in the Compendium include level 6. This is confusing.

Also confusing is the relationship between the levels and the Key Stage 3 and 4 programme of study. Is it possible to achieve levels 9 and 10 without studying the extension material? Or does the main programme of study relate only up to level 8, with the extension material progressing to 9 and 10? Study of the text does not make this clear. What is clear is that the relationship between the level descriptions and the Key Stage 3 and 4 programme of study in particular has not been clearly thought out and communicated in the document.

We are firmly of the view that levels 9 and 10 material should be retained in the Order, even if Key Stage 4 is removed, given the range of attainment in mathematics which is possible amongst pupils in Key Stage 3.

**Pupils Should be Taught to…**

It is irritating that this phrase is consistently followed by a phrase which does not make grammatical sense, eg "Pupils should be taught to .... Developing mathematical language."

Even if this phrase were to be moved to a position underneath the headings there are times when it would not make educational sense. Throughout it emphasises only teacher activity rather than pupils learning actively.

We do not wish to play down the importance of 'teaching' but much mathematics is only learnt through individual and group activity. As it stands the phrase leads to such nonsenses as:

"Pupils should be taught to .... explore addition and subtraction patterns" and "pupils should be taught to .... progress to understand the operations of multiplication and division."

There would be more pedagogical sense in the use of a phrase such as: "Teaching and learning experiences should enable the pupil to .... "

**Overall Mathematical Content**

We find the proposals disappointing in the extent to which they recognise the technological age in which pupils are learning their mathematics. In particular, more attention should be given to the implications of computers and graphic calculators for what is important in learning mathematics, and more encouragement given to teachers to incorporate all aspects of information technology into their mathematics

teaching.

The content overall is curiously old-fashioned, with no mention of many significant mathematical developments since the 17th century, even in the higher levels, and a continued over-emphasis on arithmetic in the primary age range. Although we are in favour of retaining levels 9 and 10, the proposed content of these levels is currently an incoherent collection of left-over bits of mathematics.

There is a clear attempt at progression through the programmes of study, but there is a danger that the structure of the level descriptions will encourage teachers to adopt a linear, hierarchical model of teaching and learning mathematics which is not supported by any research evidence.

In terms of balance between knowledge, skills and understanding, there is a danger that if the opening paragraphs are ignored and teaches focus only on the bullet points, or, worse, the level descriptions, then the balance will swing too heavily towards the performance of routine skills and not sufficiently in favour of the development of genuine understanding of and appreciation of mathematical ideas and processes. The format of the document should guard against this danger.

*(NB The response also included a list of miscellaneous points, which are not included here, related to specific matters of details in the wording and mathematical content of the proposals.)*

**Reference**

Department of Education and ScienceIWelsh Office (August 1988) *Mathematics for Ages* 5 *to* 16: *Proposals of the Secretary of State for Education and Science and the Secretary of State for Wales* London: HMSO

National Curriculum Council (December 1988) *National Curriculum Consultation Report: Mathematics* London: HMSO

Department of Education and SciencelWelsh Office (1991) *Mathematics in the National Curriculum* (1991) London: HMSO

Schools Curriculum and Assessment Authority (1994) *Mathematics in the National Curriculum, Draft Proposals: May* 1994. London: HMSO.



**Original pagination of this article – pp31-37**