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Addendum to the Oxford Proceedings.

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How young children share and divide.

We presented two sets of experiments, the first on young children's understanding of proportion and the second on the way in which young children share out equal quantities. Our central argument was that these two forms of early understanding are linked because sharing involves making equal quantities and the child's first understanding of proportion is based on the half i.e. the equals borderline. Our idea about proportions is that children first understand simple relations like smaller and larger, and then apply that to proportions by realising that part of a quantity is greater than the other part (more than half) or less than the other part (less than half) or equal to the other part (half). Here the boundary line is half and so our prediction is that young children will be able to make proportional comparison when these are between different proportions that cross the half boundary i.e. they should be able to tell two quantities apart on the basis of proportions if one is 3/8ths of the total and the other 5/6ths - since one is more than and the other less than half of the total. They should have more difficulty when one proportion is 3/8ths of the total and the other 1/8ths. A series of experiments showed that this pattern occurred with children of 6 and 7 years.

In the sharing experiments we showed first that even four year old children are adept at sharing out quantities. However they seem reluctant to involve actual number in sharing since having shared out quantities equally and having counted one of the shared proportions most (though by no means all) of the four year olds were unable to infer how many items there were in the other portions. Four year olds also had difficulty with a task in which the actual units that they had to share out were different for each recipient (one recipient getting single and the other doubles, for example). When this happened four year olds tended to be at a loss, though five year olds did rather well. However this particular task is easily trainable with the help of colour cues, and we take the ease of training to mean that even four year olds have a basic though not always effective understanding of one to one correspondence.

We also note that this singles/doubles task can be formalised as 1 x 2 = 2 x 1, which means that we have been studying the beginnings of the understanding of commutativity of multiplication. Some of our current work is pursuing this topic with older children and larger and therefore more complex units (3, 4, 5, 6).

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INSIGHT FROM SMALL-SCALE RESEARCH

John Costello, Department of Education
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Small-scale research is very common : many teachers carry out their own classroom projects, often to produce a dissertation as part of a taught masters degree course. This exercise is of obvious value to the teachers concerned, but perhaps we ought to consider how general insights might be derived from such work.

One good example is provided by a recent dissertation which discusses adolescent perceptions of gender differences in learning mathematics. It is based on a study of the views of 15/16-year-old students in a Leicestershire upper school. Of these students, approximately equal numbers believe that there is no difference between boys and girls in this respect, that boys are at an advantage, and that girls are better. These figures are comparable to those identified by the APU nationally. However, by probing the detailed reponses of the students in the present study, a common thread emerges. The predominant impression is that boys have the confidence to answer immediately and often impulsively or spontaneously in class whereas girls are more careful, conscientious, meticulous and perhaps reflective. Whether this phenomenon is true or not, the majority of students express some idea of this kind. Interestingly, this can make you believe that girls do better or that boys do better : perhaps it tells us more about what the students think being good at mathematics involves, rather than their perception of gender differences.

A second, in some ways less convincing, dissertation describes the response of 11-year-old pupils in an 11-16 comprehensive school to "investigations". Teachers introduce investigations into mathematics lessons for a variety of reasons - to encourage pupils to devise their own strategies for solving problems, to vary the style of class organisation, or just to provide coursework for GCSE. In this school, the mathematics curriculum is based on an individualised learning scheme; and the pupils viewed the investigations as a somewhat unwelcome interruption to their work. In subsequent discussion, however, most tried to rationalise the experience and claimed that it had been worthwhile; but their positive evaluation was generally in terms of the opportunity provided to practice specific skills or reinforce previous knowledge rather than in terms of any strategy objective. It is hard to know whether this has broader applicability than within the particular school; but informal discussions suggest that such a response may be fairly common.

Finally, a third dissertation attempts to classify children's talk while working in groups on mathematical tasks. This is something very elusive, but at least the study succeeds in quantifying the proportion of talk in various categories, for example, directly on the task or peripheral to the task. It is clear that the proportion of talk which is directly related to the mathematical work depends on a number of factors, including the ability of the group, the cognitive demand of the task and the amount of structure imposed by the instructions. However, insufficient examples have been analysed to provide any overall theory about these relationships - the dissertation must be considered as providing a framework and a starting point for further investigations.

COMPUTATIONAL ESTIMATION STRATEGIES OF PROFESSIONAL MATHEMATICIANS

by Ann Dowker, Department of Experimental Psychology, University of Oxford

35 professional pure mathematicians at various universities were given a computational estimation task. The test used was the same as that used by Deborah Levine (Strategy Use and Estimation Ability of College Students ; Journal for Research in Mathematics Education ,1982 ,13,350-359) in a study of U.S. college students not majoring in mathematics. The mathematicians, like Levine's undergraduates, were asked : "Estimate the approximate answers to the following sums." 20 sums were presented , 10 involving multiplication (e.g. 187.5 x 0.06 ; 64.6 x 0.16) and 10 involving division (e.g. 25410 ÷ 65 ; 66 ÷ 0.86).The task took 15 to 20 minutes and was recorded on a tape-recorder. The subjects were asked to describe the strategies that they used in making their estimates. Each answer was given a score from 0 to 3, depending on the percentage of error. The maximum possible total score was 60.

The main results were as follows. Firstly, not surprisingly, the mathematicians were very accurate estimators. The average score was 52, as compared with 25.9 for Levine's non-mathematician subjects, though only 3 of the 35 mathematicians obtained perfect scores of 60. But the most striking aspect of the results was that the mathematicians used a very great variety of strategies. The highest number of strategies used for a single problem was 22 by 22 mathematicians for the problem 546 ÷ 33.5 .The lowest number was 5 for the problem 424 x 0.76. 15 of the 20 problems elicited 10 or more different strategies, despite the fact that some had clearly been designed with a view to eliciting a particular strategy.

Here are a few examples of the 12 strategies used in estimating the answer to the sum 187.5 x 0.06 (exact answer 11.25):

(1) 190 x 0.06 = 1.9 x 6 = 11.4 .
(Strategy used by three mathematicians)

(2) 200 x 0.05 = 200 x 1/20 = 10 .
(Strategy used by two mathematicians.)

(3) 0.06 is about 1/15. 180 x 1/15 = 360 x 1/30 = 12 .
(Strategy used by one mathematician.)

Every mathematician used, for at least one problem, some strategy that had not been used by the other 34. Even more striking evidence of the versatility and flexibility of the mathematicians was obtained when 7 of them were retested after an interval of several months. All used different strategies for at least 8 of the 20 problems on the two occasions , and two used different strategies for as many as 14 of the problems.

It should be emphasised that nearly all the strategies used were reasonable ones. Even of the 71 responses that scored 0, only 4 involved the use of a really inappropriate strategy. (Most involved calculation errors - in 44 cases , resulting from a failure to adjust the decimal point.)

These findings about the variety of strategies used by the mathematicians have a bearing on several topics :

(1) From an educational point of view, they emphasise that there may be a large number of reasonable strategies of solving a mathematical problem; that it may therefore be a mistake to assume that there is only one way , or only a small number of ways, to learn or teach mathematics; and that children's own invented strategies should not be disregarded.

(2)They may be relevant to the findings of Terezinha Carraher, Analucia Schliemann, Sylvia Scribner and others that people (here, even highly educated, academically successful people) often devise their own non-school-based techniques of solving mathematical problems.

(3) They raise the question of whether it would be possible to design an artificial intelligence program that could imitate the mathematicians' ability to create new strategies.

GRADUATED TESTS IN MATHEMATICS FOR LOWER ATTAINERS IN SECONDARY SCHOOLS: a feasibility study

Derek Foxman, NFER

The project was set up to study the feasibility of devising tests in mathematics at several levels of difficulty, for lower attaining pupils aged 14 to 16. Such a series of tests is generally referred to as 'graded' or 'graduated' tests. The project was one of three commissioned by the DES in their post-Cockcroft Report programme of research development. The Welsh Office provided funds to include two LEAs in Wales in the project and to carry out some testing in Welsh.

The work was carried out in association with 69 schools in 19 LEAs. In 8 of the LEAs, teacher liaison groups were set up to discuss assessment results and the emerging feasibility issues. The liaison group schools also helped to trial the assessments. In the second phase of the project, three schools from each of 11 LEAs in England provided facilities for trying out amended versions of tests first used in liaison group schools.

The project used the assessment framework developed for the APU and the results obtained in the national mathematics surveys as the starting point for test development in this project. The content of the tests was related to the Cockcroft foundation list.

During the project assessment materials were developed in a variety of modes. These included written, practical, oral, mental tests and a few microcomputer administered tasks. There was also a limited enquiry into the assessment of investigative work. The teachers' dispute affected the liaison group meetings and slowed development on practical, oral and investigative assessments. However, some development was possible in each test mode.

The target sample

The testing was carried out almost entirely with lower-attaining 4th year pupils. 'Lower attainers' were variously described in the Cockcroft Report as "the lowest 40% of attainers" and "those for whom CSE is not intended". In this project the target pupils were identified initially in terms of the mathematics set in which they had been placed by their schools. However, it was clear that the schools, with differing characteristics, would have different proportions of the "lowest 40%"

nationally. Consequently, a reference test of APU written test items was developed which was focused on the middle of the lowest 40% nationally. Using APU records it was possible to select items which had the required range of difficulty and were also likely to be attempted by lower attainers. All pupils in the samples took this test in addition to the tests developed for the project. Pupils were assigned to one of three attainment bands on the basis of the results of the reference test, each band consisting of one third of the target pupils.

Graduated tests: feasibility issues

Overall feasibility involved examining:

(i) current levels of performance of the lowest 40%;

(ii) how a set of graduated tests based on this performance would work; how performance and levels of performance could be described using criterion referencing;

(iii) problems for pupils and teachers in using and organising assessments in schools.

Current levels of performance of the lowest 40%

The bottom third of the lowest 40% could successfully answer questions involving fairly basic processes of counting and calculation carried out on paper, mentally, and with a calculator; direct readings from tables of data; the recognition and drawing of familiar shapes; some simple visualisation tasks; reading scales at a labelled gradation. General knowledge about measurement units was lacking. Most pupils in the bottom third were thoroughly confused by the dual system of measurement: metric and Imperial. The top third of pupils had difficulty with topics from the Cockcroft foundation list such as understanding of fractions, percentages, negative numbers, measuring scales and units. They also had severe difficulties with decimals.

There were differences in the performance of boys and girls in different topics. Boys generally performed better on any questions concerned with measurement and the understanding of place value. Girls had equal or higher success rates than boys on questions about calendar dates, the cost of goods and computation with whole numbers.

For the "lowest 40%" overall, calculations with a calculator were done well when the context was familiar, the numbers involved could be easily interpreted, and the structure of the calculation was simple. Orally-presented mental tests offered no advantage in terms of success rate over written presentation of the same questions.

How a set of graduated tests based on this performance would work

Using current performance as a basis, possible levels of difficulty in a graduated test scheme were constructed and evaluated within and between topics.

- Performance within a topic was consistent, harder tasks usually being passed only if easier ones in the same topic had been successfully tackled.
- Questions exemplifying a given task covered a wide range of success rates. Consequently, questions on different aspects of the same task could be placed at different levels in a scheme.
  For example, questions on procedural aspects of a task are generally easier than those on understanding the related concepts. Questions
  on procedural skills would therefore be placed in lower levels of a scheme than those on understanding, thus fragmenting the curriculum.
- Performance across different topics showed a fair amount of variability. Profiles rather than statements about general levels of performance might therefore be considered.
- There would be a differential pass rate for boys and girls in some topics.
- Performance on the same tasks on different occasions was variable for many pupils. This has possible implications both for the wording of statements of achievement ('has done...', 'can do with practice...', 'can do...') and for the degree of mastery required for such achievement to be recorded.
- Four levels were used for the analyses. It is considered that this is the largest number of levels into which the performance of the lowest 40% can be distinctively divided.

Describing performance: Criterion-referenced assessment

While criterion-referenced assessment is not essential for a graduated test scheme, the project's brief was to study criterion-referencing in such a scheme. A number of problems were identified, relating particularly to what criteria should be tested, what constitutes mastery of a criterion, and how to describe performance to different audiences. For example, the context of the mathematics influences the difficulty of questions; consequently a mathematical criterion achieved in one context will not necessarily be achieved in another. Also, performance can vary over time.

While there are likely to be benefits for teachers by engaging in the process of analysing subject matter, writing criteria, constructing assessment tasks and evaluating the results, a good deal of INSET would be required for the potential benefits to be realised.

Organising graduated tests in schools

- Teachers were impressed with the involvement of their pupils in practical and oral work but had reservations about organising the tests and the availability of resources - staffing and apparatus.
- Teachers associated with the project were equally divided on whether they preferred "off the shelf" assessment, developed by others, or one developed by their school or a consortium of schools. A central development would have to be sufficiently flexible to meet local and individual needs.

It was considered feasible to gain a good deal of evidence of the attainment of "the lowest 40%" in positive but qualified terms, at different levels of difficulty. However, a number of problems were identified. Not all topics in the Cockcroft foundation list would be covered, particularly at the lower levels. If pupils are to achieve success in accordance with the Cockcroft philosophy, questions would have to be allocated to levels on the basis of their difficulty, with concomitant dangers of fragmenting the curriculum. In particular procedural skills would be separated from conceptual aspects for some topics on current performance. There would be differential success rates for boys and girls in several topics.

The report concludes that different approaches to improving pupils' attainment and motivation should be compared with graduated tests, for there may be more educationally efficient ways of bringing about the changes recommended by the Cockcroft Committee.

INVESTIGATING A NEW FRAMEWORK FOR MATHEMATICS TEACHER EDUCATION: AN ACTION RESEARCH STUDY

A paper presented at the British Society for Research into Learning Mathematics Conference held in Oxford on 5th March, 1988.

Linda Haggarty.

1. Introduction

September 1987 marked the start of a new style of initial teacher training course at O.U.D.E.S. The course, the Internship Scheme, has developed through the cooperative working of the staffs of the department and the local schools in Oxfordshire L.E.A.

At the heart of the scheme is the idea of a close partnership between the University department and the secondary schools and teachers of Oxfordshire. School staff are full partners with their University colleagues in planning, implementing and evaluating the content, activities and procedures for this new programme. The partnership operates on the simple principle that those in different positions should each contribute, taking account of their place of work, the expertise they use in other aspects of their daily work, and the time they have available. It also acknowledges that a University department may not be the best place to offer practical advice.

The tasks and experiences for the prospective teachers in the University and their link schools are planned to complement each other rather than being two different and separately planned agendas.

This is not an apprenticeship scheme, with the mentor* cast in the role of master teacher, to be emulated uncritically by the intern*. Equally, it is not a theory into practice scheme, with general ideas of good practice being taught in the University in the hope that they can be observed and practised in more concrete terms in the schools. The Internship Scheme, in contrast to both of these, puts the emphasis on the intern as an active, intelligent and critical learner; both the ideas and practices of the mentor and the more abstract ideas acquired in the university are to be subjected to critical examination and testing. In particular, practical ideas have to be assessed in theoretical terms and theoretical ideas have to be assessed in terms of their practicality.

The interns work in pairs and work with the curriculum tutor for mathematics in the University and their mentor in school.

*SOME VOCABULARY OF THE SCHEME

Mentor - An experienced teacher who takes an agreed responsibility throughout one school year for two interns in his or her own subject(s).

Intern - A member of the P.G.C.E. course working alongside one other intern. There will normally be 10-12 interns within a cooperating school, spread across the main areas of the curriculum.

Curriculum tutor - A member of the Department staff specialising within a defined curriculum area (e.g. Mathematics), responsible for supporting and leading a team of mentors and providing the relevant context for the work of all the interns within the defined curriculum area.

2. The mathematics curriculum

The first challenge, therefore, was to design a mathematics component of the course which satisfied the principles of the Internship Scheme.

At the beginning of the last Academic year, therefore, I decided to look at three quite different areas of concern in mathematics teacher education and see if I could develop materials which would satisfy the principles. If I could get those - what I called modules - right, they would help me to develop the rest of the course.

The 3 modules were concerned with

- how teacher action can influence pupil motivation
- how teacher action can influence the achievement of girls in mathematics
- introducing interns to a range of teaching styles and the relative strengths of those styles in different situations.

Given that I was curriculum tutor and could decide on my own actions, what I needed to consider was how I could persuade subject supervisors to play the parts of mentors and students the parts of interns and test out some of the ideas.

The research questions I posed were:

1a) How can modules be designed so that interns test and reflect on the materials in them?
b) How can modules be designed so that interns achieve an understanding of the Issues involved?
c) How can modules be designed so that they persuade interns to carry out the recommendations in them?
2a) How can mentors be got to take an active part in the development of the modules?
b) How can mentors be persuaded to get the interns to carry out and reflect on the activities in the modules?

3. Choice of research method

I chose to use action research because I knew what I wanted to do but I needed to find out how to design materials and work with mentors and interns so that we could all play our parts.

I also found this research method appropriate because I was able to discover not only what parts had gone well but also what hadn't worked and why it had not worked.

4. Actions taken

My hypothetical solution to the research question was to take a number of actions:

1) I felt there was a need for detailed practical guidance for both interns and mentors about what they should do. I therefore produced a set of materials for each of the three modules and these materials, which also included details of what I as curriculum tutor would be doing, were given to all the interns and mentors involved in the trialling.

2) The general ideas of what was meant to be happening should be shared with and understood by mentors and interns. To achieve this, I set up a series of meetings with each group to outline the plans and allow for each group to clarify their understanding of those plans.

3) Because I was trying to initiate this, I did the bulk of the work although I gave mentors every opportunity to influence what I did and to feel, because of the way the meetings were handled, they had acquired ownership of the materials.

Another important point was that the meetings were seen as opportunities to strengthen relations between the Department and the schools - a necessary first step towards the equal partnership required in the scheme.

5. Collection of results

The trialling went to plan and I collected results from:

i) student assignments
ii) student evaluation sheets
iii) sudent feedback sessions
iv) individual semi-structured taped interviews with supervisors
v) supervisors feedback sessions.

6. Results and conclusions

Essentially the results were good - the hypothetical solutions appeared to provide answers to the research questions. In terms of the first research question:

- All 15 students did the necessary trialling of the intern role and took all the necessary actions.
- Students were reluctant to use criteria to formulate their own theories. They were keen to do the testing, observing, discussing and recording but not that keen to say what conclusions they finally reached.
- Some interesting comments from the students included:
  'I don't know if I reflected on the issues but I certainly thought hard about them'.
  More seriously, time pressures were a problem:
  'How can we be expected to think about pupil motivation when we have all these lessons to plan'

-but by the end, many were suggesting that the assignments should be extended.

In terms of the second research question:

- 6 of the 8 supervisors who had agreed to trial the role of mentor did so.
- They were concerned about the lack of time to discuss developing theories with the interns but in fact gave that time (in the actual scheme they will be allowed some time for this)
- Students found that observing teachers was problematic, particularly when it came to the styles of teaching module. Possible reasons might be that supervisors had decided in the past that observing lessons was a fairly passive activity - and rather a waste of time; also that their lessons (in the styles of teaching module) were not 'special' enough to observe.
- The supervisors were very supportive - in fact all wanted to be mentors in the actual scheme.
- They were also very appreciative of the actual materials - INSET etc.

7. By the end of the year

Once the trialling and subsequent modifications of the materials had been completed, there existed a situation in which:

a) Mentors were expressing an enormous amount of goodwill. They liked the way the modules had been designed and the detail included in them and they appreciated my efforts as curriculum tutor. They wanted to help to develop more materials of the same kind although they saw it as essentially the curriculum tutor's responsibility to do all the writing.

b) Mentors seemed unwilling to dissent from O.U.D.E.S. perspectives so that any lack of consensus was not explored.

c) They seemed reluctant to expose the realities of their own classroom practice to their interns.

8. A way forward for the research

Despite this enormous amount of goodwill, mentors did not seem ready to implement two fairly fundamental aspects of the scheme so I decided to focus my attention on the mentors and to begin to understand how they approach the task of mentoring and why they behave in certain ways.

The new research questions I posed were:

1. How does each mathematics mentor approach their task of mentoring with particular reference to the three modules trialled in the first part of the research.
2. How can I best help all the individuals to fulfil their roles as mathematics mentors?

9. Current state of the research

I concentrated on the first of the research questions, assuming that I would gain a great deal of information in answering this which would inform me of appropriate actions to help others fulfil their roles.

There are 20 interns in mathematics this year working in 10 schools and I work closely with 5 of those schools. I decided to ask the mentor and interns from each of those schools to help me in a number of ways:

i) Interview each mentor at the beginning of the year in an unstructured way to discover, essentially, how they had set about their mentoring and what their plans were

ii) Interview each of the interns at the beginning of the year to discover how they saw the mentor's role

iii) ask each mentor and pair of interns to tape the conversations they have which are concerned with the issues from the three modules

iv) interview each of the mentors and interns again to find out how things had worked out in practice.

All the mentors and interns agreed to take part in the research and, having completed the initial interviews, I am now involved in a content analysis of the taped conversations between mentors and interns.

10. Principles underlying the content analysis.

The content analysis is designed in relation to the basic ideas of Internship as they relate to the mentor's role such as:

- are ideas from different sources being discussed?
- What kinds of judgements do mentors make in relation to the interns and the materials?
- do they discuss theoretical ideas raised in materials or do they discuss things only on a

practical level?

- do mentors discuss issues in terms of practicality and pressures upon them? To what extent do they also concern themselves with broader issues reflected in the theoretical literature?

At a theoretical level I see this research as contributing to an understanding of the possibilities of the active engagement of experienced teachers in the professional education of beginning teachers at a depth which has not been attempted in this country in the last century. At the same time, it also explores the limitations which active engagement in the day to day work of teaching and the day to day life of the school imposes on the kind of contribution they can make.

At a practical level, the research is designed to lead to fairly immediate improvements in the mathematics component of the Internship scheme.

Linda Haggarty

March, 1988.

Discussion Group: LEARNING GRADIENTS IN MATHEMATICS

Rainer Lant, Memorial University of Newfoundland (retired).

a) Exposition: Mathematics is hierarchically organised. Learning gradients are created by the co-ordination, subordination and superordination of processes. These conceal different types of difficulty. For example, addition is subordinate to binary operation and to multiplication, but different learning difficulties arise from these. -- Ideally we should be able to provide each pupil in every lesson with a gradient that requires some effort and can at the same time be climbed. The various ability levels require gentler and steeper gradients. This would make for very lengthy textbooks, but the material could be more easily stored, supplemented and edited on a disc.

b) Discussion: The gradient of the exposition suggested a simple slope. A better model could be provided by the helix, with the fast learners climbing along the steepest path from coil to coil. -- Concepts are consolidated by being encountered at intervals. Consolidation through revision is therefore part of the climb, but initially a concept may be 'caught' by the pupil in the course of some activity not specifically intended to present it. -- Gentle gradients mean a slow step-by-step approach. As a result the initial basis of a concept may be too narrow. Children who learn multiplication of whole numbers only at the beginning often have difficulty in adjusting to the multiplication of fractions later on.

THE PAINS AND PLEASURES OF INSERVICE WORK IN PRIMARY MATHEMATICS

A small group joined together to discuss in-service work in primary mathematics. The discussion was led by John Price, who was delighted to discover that the group's interest in the subject meant that it was often difficult for him to get a word in edgeways. In sub-groups we considered what aspects of the work caused pain and what gave pleasure. Some suggestions were:

Pains

1. The intensity of working with teachers.
2. The "selling" of in-service course in a market-place economy.
3. The lack of time to do a good job.
4. The insecurity of not having primary experience.

Pleasures

1. The enthusiasm of teachers.
2. The learning that comes from co-operative work with teachers.
3. The opportunities to teach children alongside other teachers.
4. The effect that such courses have on classroom practice.

The group were then invited to address the questions:

(a) What do teachers want from in-service courses?
(b) What should they get?

It was quickly discovered that none of the group were primary teachers who might give insight into the first question and this was some cause for concern. Was the BSRLM no longer attracting primary teachers? As for the second question, no conclusions were reached but the discussion was worthwhile. Do any that were unable to attend this meeting have strong opinions on either question? John Price at Westminster College, Oxford would be pleased to hear from you.

THE ROLE OF THE MATHEMATICS CO-ORDINATOR IN PRIMARY AND MIDDLE SCHOOLS IN ENGLAND AND WALES

Marion Stow (National Foundation for Educational Research in England and Wales)

The NFER research highlights the circumstantial factors which affect the role of the mathematics co-ordinator. Regional variations such as school size affect the availability of teacher posts of mathematics co-ordinator; more than one third of the posts are held by headteachers. The school size and the state of curriculum and management development within the school affects the level of responsibilities delegated to co-ordinators. The demand for, and supply of teachers varies between regions. This affects both the level of qualification accepted for the appointment of co-ordinators, and the provision of education and support for co-ordinators. Despite the variation in teaching experience and in-service education received by co-ordinators, more than 90% of co-ordinators perceive a moderate or great need for training, particularly in current curriculum developments and provision for special needs in mathematics education.

The research report, to be published by NFER-Nelson in the Autumn 1988, identifies the factors which contribute to good practice in the co-ordination of mathematics at LEA, school and classroom levels.

BREAKTHROUGH TO NUMERACY?

Peter Sutherland
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This exploratory study set out: (1) to identify factors causing learning difficulties and (2) to try to find ways of helping children overcome such problems, particularly their need for concrete props. At five primary schools with widely varying intakes, pupils with especial difficulties with maths (as against language) were requested. Ages ranged from 6 to 11. Their capabilities were diagnosed and a programme of remediation initiated, lasting about three months. The action researcher's role included both teaching and observing. The main mathematical focus was on 2 digit addition and subtraction.

General findings included (1) a lack of gender differences (although boys were referred by teachers more often than girls, by a margin of 16 to 9); (2) problems with short term memory and motivation; (3) startling differences between performances at schools in distinct social areas: far better in an upper middle class and far worse in an inner city multi-cultural school, and (4), related to this, there were huge differences between homes in the help and opportunities they gave to their children. This varied from a wealthy two parent family where both parents would play number games with the child and there was plenty of pocket money, to a single parent family where the breadwinner was unemployed and no number activities were initiated by the parent.

Specific findings for maths education were many. A failure to understand the concept of place value underlay most of the difficulties. Subtraction by double decomposition was mastered by very few. Money was the best way of motivating the children. Contributions from the floor suggested that real money and real sweets would have been even more effective than money tokens and simulated problems.

A major focus of the study had been the ability to extract a 'sum' from a situation, to correctly perform the computation and to translate this back into the 'real life situation'. The vast majority of the pupils failed to do this. This aroused a great deal of discussion from the floor. Prof. Schwarzenburg suggested that such an expectation is peculiar to our culture. Another contributor suggested that the action researcher had inadvertently cued the pupils into this response by his use of language.

The inability of some young chidren to understand the equivalance of 2 1p's as 1 2p led a further contributor to emphasize the need for teachers to allow visual images to impinge strongly on their pupils' brains.

The calculator was little used at the five schools. When it was used most of the pupils studied could not estimate whether their answer was approximately correct or not.

The strongest implication for teaching was the need for 1:1 teaching. Formal class teaching had made little impact on children far 'behind' the rest of the class. Unfortunately there was no awareness amongst teachers of pupils' own learning strategies.