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Contents

Discussion Group: QUESTIONING

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It was intended that the work of this group would be centred on comparison and discussion of two video sequences of teachers working with small groups of children, chosen to illustrate different styles of questioning. Technical problems (the VCR wouldn't work for some time) meant that there was time to use only one of the extracts.

As a basis for this discussion, categories were suggested for the *purposes* of teachers' questions, as in the discussion group run at the meeting held at the Open University earlier this year [1]. While some members of the group wrestled with the technology, there was some valuable discussion about factors which might alter perceptions of the purpose of a particular question; for example, a question asked by someone who is in the role of 'teacher' (e.g. supervisor with graduate student, researcher with teachers) may be percieved as a testing question, even when it is a genuine request for an opinion or information.

Work with the video extract followed the pattern I am using to try to ascertain teachers' and pupils' perceptions of particular questioning situations. After watching sufficient of the extract to set the scene, I stopped the tape after an exchange in which the teacher had asked a question, and asked the group about this exchange, e.g. Why do you think the teacher asked that question? Small groups recorded their responses on paper (albeit with some reluctance), and we spent some time comparing these with the responses given in previous interviews by teachers, children and mathematics educators. In the small sample considered the most striking mismatch between the perceptions of children and those of adults was in the pace of the lesson, and the thinking time allowed.

The session ended with the suggestion that categories to describe children's perceptions of the purposes of questions might be quite different from the categories of adults' perceptions.

[1] See BSRLM proceedings for 24th January 1987.

Research Report : Contexts of Numerical Activity among Adults

A literature review aimed at developing the idea of "context" suggested the following aspects were important for mathematical activity:

- material resources e.g. computational technology (Maier, 1980)
- goals , beliefs, values (Cobb, 1986)
- language (Carraher and Schliemann, in press; d'Ambrosio, 1985)
- basis in a social group, socialisation (d'Ambrosio, 1985; Cobb, 1986).

In terms of relating performance and context, the fundamental problem is that of deciding whether completing a ratio problem at school, and a task in carpentry say, that would appear the same to a mathematician, are "the same task in different contexts", or "different tasks". (This is related to the question of whether you are "doing mathematics" when you are making a patchwork quilt, which came up in Mary Harris' interesting Workshop.) Of course, in order to make comparisons between performance levels in school and "practical" contexts, as several researchers have done (Carraher and Schliemann; Lave et al. , 1984), you must presuppose that the answer to the above dilemma is "the same task in different contexts".

On the other hand, some researchers have insisted that task/contexts cannot be prised apart so easily (e.g. Walkerdine, forthcoming). This position has the virtue of explaining why <u>transfer</u> from school maths to practical contexts is so difficult.

In my research, I have drawn on ideas from this second position, and attempted to think of contexts of mathematical activity as "(discursive) practices". These practices are systems of social activity which are shaped by language and which give meaning, including emotional charge, to it. Most practices have some numerate aspects and include procedures for making calculations, etc. Practices make available certain "positions" (of power) to people; thus, for example, formal education makes available positions as "teacher" and "pupil". For a person in a given situation, a particular practice (or occasionally, more than one) is "called up"; this conditions their conception of the "task", what "skills" they deploy, and the "emotions" experienced.

The context of the research

In a study of the contexts in which adults use numbers, a number of three-quarter-hour interviews were conducted with Social Science degree students at the end of their 1st year (which includes a Maths / Stats./ Philosophy of Science course). They were presented with a number of questions which I thought might appear to be from a variety of practices, e.g.school maths, shopping, eating out, cooking, and were asked three questions for each :
- which of their activities it reminded them of;
- how they were thinking about the question , and their answer; and
- what the problem reminded them of in their early experiences with numbers.

Research Questions

QUESTION (1) Which contexts are called up by numerical questions in the interview ?

In order to ascertain which, we can draw on various indications (Walkerdine, forthcoming, Ch. 3) :

(A) the explicit discursive features of the task/situation
* e.g. what the task is called : 'test', 'game', etc.

(B) interactional aspects of the researcher's performance, not "scripted" in the research dèsign
* e.g. different verbal , vocal, non-vocal signs for 'correct' and 'wrong' answers; and

(C) responses ond comments given by the student during the interview
* e.g. language used in thinking about the question and giving answer esp. the response to the question : "What activity that you do these days does this question remind you of?"

(D) reflexive accounts.

My provisional conjectures were :

(1) There are two main practices/contexts, with related positions, available, viz.
(T) formal (College) teaching (Maths)
positions : teacher/ student
(R) social research
positions : researcher / respondent
(2) The context of formal teaching may overwhelm the context of research; i.e. (T) may tend to be called up far more frequently than (R).
(3) To the extent that (R) is called up, students will have more access to "skills" etc. from practices other than school maths.

QUESTION (2) What are the differences in performance between practical maths and school maths in interview ?

INDICATORS of "performance" - its "level" and quality were :
- correctness
- what S said during thinking
- how it was said.

In the session, we looked at the transcript of one interview in detail.

Provisional Conclusions

In this research, I want to argue for the following :
1. We can make a reasonable judgement about what context/practice a respondent has called up, by using the indicators discussed above.

2. What context has been called up will relate not only to the

"correctness" of performance, but also to the language and reasoning used with the problem.

3. More confused , less "correct" performance may be observed when school maths is called up, not only because of memory failure, "misconceptions" etc., but also because of differences in familiarity, and the emotional charge that is part of a practice. Put another way, familiarity is affective, as well as cognitive. (cf. Evans, 1987).

4. Therefore, because of the pervasiveness of the practice as context, learning of school maths is not necessarily helped by drawing on practical maths examples (Adda, 1986).

5. "Transfer" (e.g. from school maths to practical maths - or v.v.) is difficult because of differences in language, resources, social relations - and emotional associations - between different practices.

Thus we should be wary of approaches that seek to "direct the teaching of maths and science to their use in vocational work" (Kenneth Baker, Panorama, 2 Nov. 1987; approximate quote).

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The aim of this seminar was to review a number of interview transcripts which resulted from research into pupils' difficulties with the translation of 'word problems' into algebraic expressions and/or equations. Previous research, by Clement (82), Galvin and Bell (77), Kuchemann (81) and Wollman (83), has already detailed a number of typical errors and misconceptions which arise in the translation process. The transcripts reviewed here do not aim to break new ground or formulate new hypotheses regarding this aspect of algebra, rather the intention is to present a number of interesting and atypical responses from students.

The students, who were at the beginning of their Fourth Form (14 -15 years) at the time of the interviews, were taken from mathematics 'sets' of above average ability. They were selected on the basis of a written 'translation test' as making the range of errors that may be expected on the basis of the earlier research. The dominant error in the translation process was seen to be due to the 'letter as object' misconception as reported by Kuchemann.

In the first extract Katie was observed at the outset as viewing the 'letter' in the problem as standing for a missing word rather than a number or the classic 'letter as object' misconception. Later she is observed applying the correct operation (product) for the problem when it is re-stated in terms of numbers alone but when the letter is re-introduced Katie adopts an additive expression. Not only does she demonstrate an inadequate grasp of the meaning of letters in an algebraic expression but also the status of the expression itself.

In the second extract Jason is observed, firstly being misled by the interviewer who encourages him to view the letter in terms of a number and he consequently adopts a 'letter as specific unknown' frame. In overcoming this misconception Jason introduces a new letter which he equates to the correct expression for the problem. It is interesting to note that although he can equate the new letter and the expression he cannot accept them as standing for the same quantity.

In the third extract Helen is observed adopting an addition strategy for a proportion problem. Initially her proposed equation is incorrect but the suggestion to try out numbers, which work in the context of the question but not in her equation, prompt her to modify her answer to produce a correct solution. In this extract there is very clear evidence of 'scaffolding' being errected as a result of the suggestion that she checks her answer.

Discussion: The main thrust of the discussion regarded the validity of reaching any conlusions regarding the pupils' understanding, there are still too many uncertainties unresolved in the transcripts. It may be that pupils give erroneous responses, not because of a misunderstanding of 'algebra' but rather because of a misunderstanding of the word-problems posed. An opportunity to discuss the problem with the pupil before he/she attempts to write down the appropriate expression may be helpful. It was accepted that as with most problems of this nature the

situations were contrived and not really meaningful to the pupils, or 'reasonably' related to everyday life. The language of the interviewer may also create problems, e.g. the expression "what is x standing for?" has a specific mathematical meaning which may not be understood by the pupil. There is also the problem of establishing the quality of the pupils' understanding when the correct answer is given. The understanding of the meaning of letters in an expression is seen to be fundamental but do the pupils understand the use to which the letters are put in the original word problem.

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SLOW LEARNING CHILDREN AND THEIR RANGE OF RISK IN BASIC ADDITION CALCULATIONS.

Eddie Gray: University of Warwick.

Karl is a below average eleven year old. He was one of 54 children aged between 7 and 11, identified as average to below average by their class teachers, who were given a range of elementary addition calculations and through interview discussed the methods that were used to solve them.

A report of the findings obtained from interviews with the children was presented to the group.

The sample of calculations given to all of the children were in three main sections:

i) Cominations which gave answers up to ten.
ii) Combinations which gave answers in the range 10 to 20
iii) Two and three digit calculations with and without exchange.

Karl knew most of the bonds in the range to ten but in contrast, whilst dealing with the next group to twenty, used alternative strategies since he could not recall many of the facts. With larger numbers his dominant theme was to use a left to right addition process, a counting on process to form a solution and, most surprisingly, he completed the whole calculation mentally.

Karl was not unique. Like many other children in the sample, he used a variety of strategies to deal with the calculations and illustrated that the assumption that any one was dominant needed to be treated cautiously.

Generally the children interviewed did not know their number bonds with the confidence that we may normally expect. To overcome their shortcomings they used a variety of strategies. A strategy involving some form of count-on frequently complimented any recalled facts and was brought into use, not only if simple bonds were not known, but also even if they were known but part of a larger number involved in a calculation. Further, lack of confidence in recalling basic number facts frequently manifests itself in the regression to a less sophisticated startegy; mostly count-on. This seems to be particularily true when dealing with the number combibations to twenty.

At such instances children appear to regress in their level of strategy sophistication. With larger calculations, unless this strategy sophistication improves, there is not only a tendency to make errors but a greater chance that the calculation may not be completed. A striking feature of those children who did oscillate between using recalled facts and counting methods successfully, is the tendency to complete two and three digit addition calculations from left to right.

There was little time for discussion at the end of the report.

A computational model of student's thinking on a proportional reasoning task.

1. Introduction

A CAL experiment aimed at improving understanding of proportion in a group of 15 mathematically weak 17-18 year olds was carried out. The students were interviewed before and after the experimental intervention using a test based upon the lemonade puzzles developed by Karplus.

In an attempt to accurately characterise the changes that had occurred between the two testings it was decided to model the student's behaviour on the tests as production systems. It is these models that are described here.

2. The proportional reasoning task

Students were shown a card indicating four flasks, two flasks for John and two for Mary. Questions were posed in this form:

John makes orange squash by using _ spoonfuls of concentrate and _ spoonfuls of water.
Mary makes orange squash by using _ spoonfuls of concentrate and _ spooonfuls of water
Whose orange squash has the stronger taste?
Please explain how you worked out your answer.

3. Student strategies

The strategies the students used were classified as follows:

- naive (mainly "Don't know")
- addition
- doubling within
- doubling between
- simple multiplication within (multiplication by 3-5)
- simple multiplication between (multiplication by 3-5)
- remainder
- fractions (including ratios)
- decimals

A within strategy involves comparing John's concentrate to John's water and then comparing this with the relation of Mary's concentrate to Mary's water.

A between strategy involves comparing John's concentrate to Marys concentrate and then comparing this with the relation of John's water to Mary's water.

The remainder strategy can be illustrated by the following argument:

John has 4 concentrate and 10 water
Mary has 6 concentrate and 15 water
For John 10/4 is 2 remainder 2
For Mary 15/6 is 2 remainder 3
2 remainder 3 is greater than 2 remainder 2, so John's squash is stronger.

Clearly some strategies (eg doubling) could only be used on questions for which they were appropriate. There was experimental evidence, however, for the distinctness of these strategies.

4. The production system models

What follows is an example model for a hypothetical student. In order to keep the model as simple as possible it has been assumed that the student did not use any between strategies. (Note: STM = Short Term Memory)

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COMPARISON
COMPARE-W1        Mary's dilution < John's dilution
                     --> say "Mary's mixture is stronger"
COMPARE-W2        Mary's dilution > John's dilution
                     --> say "John's mixture is stronger"
COMPARE-3         Can't compare --> put 'impasse' in STM
EQUALITY
EQUAL-W           John's dilution = Mary's dilution
                     --> say "The mixtures are of equal strength"
NOT-EQUAL-W       John's dilution <> Mary's dilution
                     --> ask "Is Mary's dilution less than John's?"
HAS-MARY-SAME?    John's dilution is known
                     --> ask "Is Mary's dilution equal to John's?"
SEQUENCING
CHAIN1            compare --> put 'doubling within' in STM
CHAIN2            doubling within & John's dilution <> 2
                       --> put 'simple multiplication within' in STM
CHAIN3            simple multiplication within
                  & John's dilution is not a small integer
                     --> put 'impasse' in STM
CHAIN4            impasse --> put 'add' in STM
ENCODING
DBL-W             doubling within
                     --> ask "John's dilution equals 2?"
SMULT-W           simple multiplication within
                     --> ask "Is John's dilution a small integer,
ADD               add
                     --> ask "John's dilution is 1 and how many?"
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In order to stress the points at which encoding takes place the production system model asks at various stages for an encoding of the relationships rather than supplying one. Each encoding given to the system is then added to STM.

There are four groups of rules, and thus four types of differences between students:

- comparison rules
  - these handle the situations where a comparison has been made, or where a comparison can not be made
  - rules can be 'buggy' (ie gave the wrong mixture as stronger)
  - rules can be missing
- equality rules
  - these handle looking for equality and asking for the a comparison if equality is not found
  - rules can be missing, and any non equality can create an impasse
- sequencing rules
  - these handle the order in which strategies are tried
  - 'addition' is modelled as a response (a 'repair') to an impasse rather than as a method in its own right
  - rules can express different sequences
  - rules can express different methods of dealing with an impasse (for example 'naive' and 'addition')
- encoding rules
  - each strategy is seen as an encoding
  - rules can be missing

Reporting Back of Investigations

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The 'investigation' lesson, with its structure of whole-group posing of the task, working in small groups and then, is becoming more common. What are some of the justifications for reporting back to the class and what are some of its drawbacks? Examination of small segments of videotape of actual classes generated a number of issues.

How can the the tension between wanting the pupil(s) to say what they have done, while wanting to use what they say to make general remarks about the conducting of investigative work be contended with? This can be particularly strongly felt in the case where the teacher has seen something that they feel is an instance of a higher-order process that they value (be it specialising systematically, developing notation or whatever) while circulating around the small groups. When invited to tell the class about this incident, it wasn't necessarily a salient one for the pupil (unless the teacher made a big point of it at the time), so they have no idea either what to emphasise or why this incident is being focused on. If the teacher has made the point, then why are they being asked to repeat it?

To whom is the reporter talking, anyway? If it is a conversation with the teacher, how might the teacher deflect attention to the rest of the class? If the teacher reinterprets what the pupils says for the rest of the class (playing 'audience's friend', what effect does this have on the reporter?

What justifications does the teacher offer the class for reporting back? There can be a difficulty in conveying what it is that they are being asked to do: too vague, and the pupils don't know why they are being asked it; too precise and pupils will tend to do precisely that thereby constraining what might happen, and retains the teacher's emphasis rather than the pupils. What covert justifications does the teacher have? What are the pupils views about why they have been asked to engage in this activity?

What is the role of the pupils who are being invited to listen? What are they supposed to be doing? Are they too concerned with the fact that their turn is coming up (and are rehearsing what they are going to say) to listen and attend to what the current reporter is saying?

How can pupils develop the linguistic skills of selecting what to report? (Obviously this is contingent on the perceived audience and purpose for carrying out the reporting back.) How can they work on acquiring a sense of audience, who knows what might be worth telling, as well as disembedding their discourse from the work of the group in order that someone who was not there can follow what is being described.

What sort of language (style, structure, organisation, register, ...) does the reporter use? How would you resolve the tension between the fact that increased preparation time can improve performance but also emphasises the public speaking aspect of the event (with its attendant social pressures on performance), while spontaneous requests without thought (though offering a potemntially less formal setting) can just bring recollections of the last thing that they were doing.

The next time you find yourself in a class where reporting back is being undertaken you might try loooking out for some of these issues and how they are resolved in the particular context.

Bernard Reaney The Use of Statistics by A Level History Students.

Many A level students studying arts subjects find it extremely difficult to interpret historical statistics and use them in their discussion and evaluation of arguments. Over the last year, A level classes who were being taught by the author were given a series of tests and questions designed to illuminate their understanding of simple statistics. The results provide interesting information about such students' approach to concepts such as probability, and the relationship (correlation) between two variables; and about their ability to use tables of historical data to calculate percentages, rates of change etc.

An Exploration of F.E.Lecturers'Beliefs,Attitudes,and Views concerning Mathematics and Mathematics Education

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The increasing interest in educational research that focuses on teachers' ideas has origins in the belief that any considered attempt to improve the quality of mathematics teaching would profit from some understanding of

i) how and what teachers think about mathematics and its teaching,

and ii)how their ideas relate to their teaching behaviour.

Previous research,in the late 1970's and early 1980's, was undertaken by the National Science Foundation,by Cooney and by Thompson in the USA, and by Lerman in Britain.This work provided the background and foundations for my own research, which was carried out in 1986 at a London College for FE where I teach mathematics. As my work was aimed at FE lecturers,it differs from the previous investigations, which were concerned with school mathematics teachers.

My research involved the development and administration of a bank of 6 activities designed to elicit information on lecturers'ideas about a wide range of aspects of mathematics and its teaching.These activities were designed so that analysis of the results could include preliminary investigation of the possibility that there is a relationship between lecturers' philosophical views about the nature of mathematics (e.g the status of mathematical truth) and their views about other features of mathematics(such as the degree of human creativity involved).

At the November conference, I described the administration and the rationale behind the design of the 6 activities,which are summarized below.Whilst discussing the first 4 tasks in some detail,I commented on the response rates, various difficulties and the importance of follow-up interviews for checking-out responses.

Summary of the tasks

Task 1	Questionnaire 19 items	Mainly factual background information together with 3 open question about education.
Task 2	Ranking of values	a) 18 'terminal' values b) 18 'instrumental' values
Task 3	Choosing and ranking	Reasons for student failure in mathematics.
Task 4	Choosing and ranking	Lecturers' aims in teaching mathematics.
Task 5	Questionnaire 28 items	Views,attitudes and beliefs concerning mathematics and mathematics education. Paired choice format.
Task 6	Questionnaire	Views,attitudes and beliefs concerning mathematics and mathematics education. Single item;Likert scale response categories.

Some ideas behind the content and design of the tasks originated in the results of previous research,others derived from consideration of the factors which might contribute to lecturers' views,and yet others suggested themselves after reflection on the ways lecturers' philosophical views about mathematics might affect their position on other issues,such as the student qualities perceived as necessary for success in mathematics.

Extensive discussion focussed on the possibilities and implications of using the bank of 6 tasks.For example, results can be cross-checked between tasks.One lecturer was shown to be consistent in responses to the open questions about education in task 1 and the aims in task 4,whereas another lecturer demonstrated significant inconsistency between these open questions and an item in task 5. I commented briefly here on my impression of 'theoretical' answers to some types of question.

Another possibility arose from the way the different activities/tasks give results that can supplement and highlight each other.As an example,task 3, which involved ranking reasons for failure,was analysed to show how different perspectives in lecturers' thinking could relate to different patterns of reasons chosen ,rather than to any single chosen reason considered in isolation.There perspectives can be cross-related with results from other tasks.This offers the opportunity of building up multi-faceted pictures or profiles of individual lecturers' beliefs, ideas and attitudes which could be used as a preliminary framework for further exploratory work,in case studies for example.

Furthermore,instead of using the complete bank of 6 tasks to probe teachers' thinking from different angles,it would be possible to select tasks,or even parts of tasks,relevant to particular foci of interest in various lines of enquiry.

As the administration of the tasks and analysis of the results can be tackled in different ways to suit research with various emphases and approaches,this bank of 6 activities seems to have potential as a flexible and valuable research tool. That is not to say,however, that there is not room for modification and improvement.Nonetheless,as it stands,it does provide extensive information that stimulates ideas and possible explanations,as well as the associated directions for further encuiry.

A further stage in my research involved the examination of classroom teaching using a series of observation periods.The aim here was to consider any apparent association between lecturers' views about mathematics and their actual classroom teaching.So,the results of observation were compared with those from the bank of activities.I took a similar perspective to Lerman's in that I looked at aspects of 'open' teaching,and I used a Flanders' observation schedule similar to the one used by Lerman.However,my results were surprizing in a number of respects.For example, communication events that I had expected to be rare(from previous work in schools) were not (and I discovered that this was consistent with past work involving observation at the same college,but in a different department).

Unfortunately,the presentation for the BSRLM conference did not give opportunity for more than a passing reference to the observation stage of my work.Indeed,I did not manage to go into any great detail about the other results,either. (The truth is that I became so involved in the stimulating discussion that took place that I lost all track of time.)

However, perhaps there may be an opportunity for Exploration II at a future conference!The lively interest and enthusiasm shown was so encouraging and stimulating---thank-you.

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Language and Logo

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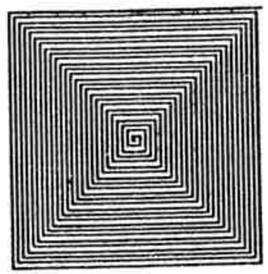
Algebra research indicates that there is often a mismatch between pupils' informal methods and the teacher's expected formal representation of the method. Within the Logo programming context, however, pupils can negotiate a generalisable method through peer group discussion and through interaction with the computer feedback.

This contribution focussed on the relationship between the pupils' formal Logo representation and their negotiation of a generalisable method in natural language. An example was taken from the three year longitudinal transcript data of pairs of pupils (aged 11-14) programming in Logo during their secondary school mathematics lessons.

The two pupils, Sally and Janet were working on a procedure to draw:



From the beginning Sally was clearly able to see a 'mathematical' relationship in the spiral. She could not at first easily express this in natural language until persistently provoked by Janet's questioning. She also held back from expressing the mathematical generalisation in the formal language of Logo. Janet on the other hand was more concerned with the very important activity of trying out specific cases and needed help from Sally in order to come to an understanding of the mathematical relationship in the spiral. Janet was more confident with using the Logo syntax and nudged Sally into using variable to formalise the generalisation.

The procedure which they finally produced was:

```
TO TEN "TWO
FD :TWO
RT 90
FD :TWO
RT 90
TEN  ADD :TWO 2
END
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From studying this transcript we see that for this pair the "hands on" interaction with the computer was essential in getting them involved with the problem. They took time to discuss and plan their solution but they needed to use the computer both as a motivator and as a means of resolving discussions. The "hands on" interaction with the computer was not separated from the planning stage.

Each transcript is only part of the longitudinal data and the analysis takes into account this part/whole dimension. Taken in context with the longitudinal data there is an observable development in Sally and Janet's understanding and use of variable in Logo. There is also evidence that they can use their Logo derived understanding in a "paper and pencil" algebra context.

An investigation to Examine Teachers' Conceptions of Mathematics and its Teaching and their possible relationship to the teacher's practice - An Exploratory Study

When working as a lecturer in teacher education I became interested in the notion of the teacher as reflective practitioner. However, I found, whilst I was engaged in INSET work in mathematics over a period of several years that for many teachers there often appeared to be a large gap between an individual's professed beliefs and their practice in the mathematics classroom. After some detailed searching of research journals etc. I came to the conclusion that little research which focussed on this area (except for that of Thompson(1)) appeared to have been carried out. I was particularly interested in work which involved a consideration of the beliefs and assumptions underlying the overt behaviour of the teacher in the act of teaching mathematics.

This set the stage for this exploratory study.
I felt as a result of my experiences that it was possible that that understandings, beliefs and values could be the major determinants of both teacher behaviour and the environments that teachers create. This exploratory study which grew out of my own concerns regarding teacher practice was an attempt to take a closer look at this situation.

The study involved two primary school teachers and was designed to explore these teachers' conceptions of mathematics and its pedagogy and to consider the teachers' actions when teaching mathematics in relation to their professed understandings, beliefs and values. It was hoped that these findings might offer further insights for future research.

The general aims of the study were to establish the existence and coherence of the teachers' beliefs, attitudes and preferences regarding mathematics and its teaching, whether overtly or covertly held, and describe the possible effects of their beliefs in the mathematics classroom.

Both teachers, referred to in the study as teacher A and teacher B, were working in the same school and teaching the same age-group of children. Both teachers had achieved an "A"-level qualification in mathematics and both stated that they felt competent and confident when teaching mathematics.

The methodology employed in carrying out the study involved observation by the researcher of the teachers at work in their classrooms and the completion by the teachers of a variety of "tasks" including the following: questionnaires, a repertory grid, a semi-structured interview and a personal construct elicitation exercise. The responses to all the instruments used were analysed for each teacher and a detailed overview presented.

The findings of the study appear to demonstrate that a relationship does exist between a teacher's conception of mathematics and their classroom practice, albeit a complex one. (This was also reported in the findings of the Thompson study).

The findings also suggest that an analysis of this relationship may have much to offer in terms of providing insights into the characteristic features of a teacher's belief system. It also suggests that some of these features may raise interesting questions regarding the nature and construction of an individual's belief system and that further study in this area may provide for a development of our understanding regarding teacher "resistance to change" and why some teachers are more successful at teaching than others.

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Research report:

No time for time?

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Over the last few years, we have been carrying out research and development work for the Manpower Services Commission in the area of vocationally related mathematics. We have been looking in detail at the work 16 and 17 year olds carry out, and the sort of mathematical problems they have when working in applied or 'real' contexts. We have also been writing materials for trainers and instructors to use with YTS trainees and other labour force entrants. These are to be published by the MSC.

It is striking how many jobs require operations involving **time**. These may be time calculations on their own, but more often, blocks of time have to be manipulated as part of a timetabling exercise. Over and over again, we find that trainees have great difficulty with these tasks. They make mistakes in time calculations: for example, of the time needed to cook a joint, or the time at which to 'rebook in' a customer who is having a perm and must have time allotted for a final blow dry. Timetabling tasks, for example when coterminous activities must be scheduled, or staff assigned to different tasks on split shifts, are extremely difficult for most young people. Yet more and more workplaces involve such complex timetabling of activities and staff time.

Our research indicates that there is a hierarchy of difficulty for timetabling tasks:

1. 'End on' tasks: times follow each other
2. Overlaps between time slots, but only one person and/or activity (eg preparing a meal for 1 pm)
3. No overlaps in time slots, but several people and/or activities (eg bookings for different rooms in a community centre)
4. Several people/activities and overlaps (many staffing rotas, holiday arrangements, hotel bookings)

It is hardly surprising that such tasks are hard for school leavers. Most school textbooks give fairly little space to time problems, and when they do, these are mostly pages of one or two step calculations. Even the ubiquitous 'reading a timetable' questions tend to be limited, easier than most real situations, and, even so, a frequent source of error. As for manipulation of timetables, how many pupils ever have the experience of altering, let alone designing, this basic organisational tool?

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