MAKING MATHEMATICS INCLUSIVE: INTERPRETING THE MEANING OF CLASSROOM ACTIVITY

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Kei te pirangi au kia uwhi koe I o karu, ka tuwhera I to hinengaro.

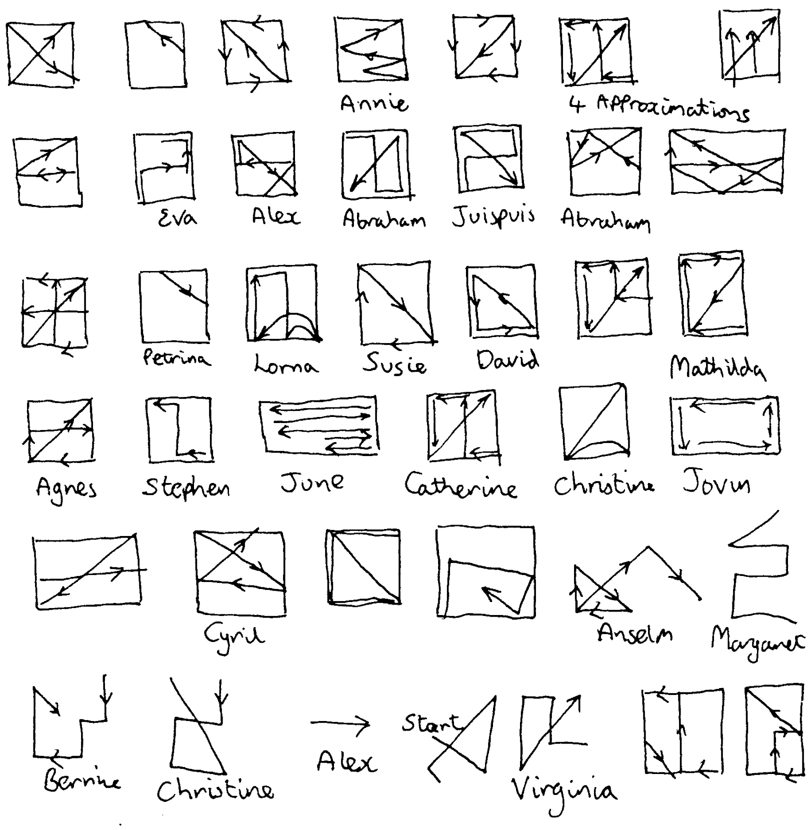
"E tu ana koe i te kokona o tetahi ruma tapawha, a, e ahu ana koe ki waenganui I te ruma. Kia ata haere te hikoi, whai haere I te pakitara, ki to taha maui kia tae koe ki waenganui. E tu. Huri ki to taha matau ka hikoi kia tae koe ki te pakitara. E tu. Huri ki to taha maui ka hikoi kia tuki koe ki te pakitara. Inaianei huri ano ki te taha maui ka hikoi kia tuki ano koe ki te pakitara. Inaianei huri ki te kokona tawhiti mai I a koe ka hikoi ki taua kokona."

INTRODUCTION

Keep your eyes closed as you imagine the following:

"You are standing at a corner in a square room, facing into the room. Slowly, along the wall to your left, you start walking until you are halfway to the next corner. You stop. You face right, and then walk until you reach the wall. Then stop. Face left and walk in that direction until you bump into a wall. Now face left and walk until you bump into another wall. Now face the corner furthest from you and walk towards it."

I constructed the above set of sentences for a group of teachers following an in-service course in Dominica some twenty years ago. This was partly related to work being carried out for my doctorate but was largely in response to a particular issue I was encountering in my school visits. It appeared that in so many lessons teachers were talking a great deal of the time and it was not always clear how this talk related to the activities of the children. At the time my doctorate was specifically looking at how mathematics could be presented so that difficulties for Patois speakers could be minimised within an English language educational medium. As part of a project a group of teachers elected to pay close attention to how they were using their speech in lessons. Within this we sought to experiment with how language worked. My intention was to explore the nature of giving directions. I was not seeking to catch the students out. Rather I hoped to choose a reasonably unambiguous set of instructions that would allow us to agree on the path I had described. I anticipated this leading to a discussion about how we communicate mathematical ideas in words. I asked the students to close their eyes and I read out my script very slowly. After a second reading students were asked to draw the path they imagined on the board. Their responses varied enormously:



There was clearly some sort of problem going on if the exercise was in some way predicated on the notion of sharing an image. But if there is a problem, whose problem is it exactly? Should the teacher work even harder at making the description comprehensible to all? Or should students work harder at following the instructions? In many ways it was the rejection of such questions that has led to my now long-standing interest in how language works and how people use it. The main theme of this work has been with appreciating the variety of responses to any initial stimulation. Simultaneously, this has led to me generally questioning notions of mathematics that set up the subject as being exclusive. Mathematics has something of an image problem where so many students feel ambivalent about the discipline's alleged delights. Could this have something to do with a recurrent insistence that the students' task is to the see mathematics in the same way as their teachers? Is it possible, as an alternative, to promote mathematics as a more inclusive subject, where the prime objective is to share different ways of seeing it rather than insisting that it be seen in particular ways? In seeking to "Make Mathematics Inclusive" I will be emphasising how we might understand mathematics and its teaching and also how we might conduct research in relation to it.

Do you know mathematics?
I speak it like a native.

(The Goons)

I have to make a confession. I do not speak Maori. Someone provided me with a translation for the opening sequence of this presentation. Translations, however, can be thwart with difficulties. In Poland I started a talk by saying “Good Evening Ladies and Gentlemen”. This resulted in howls of laughter as the configuration of “ladies and gentlemen” was only used in the context of public lavatories. But do I speak mathematics like a native? What might that mean? As a teacher, is my job about enabling children to enter the clan of mathematicians? Or is it to provide translations for my students with the hope that no-one spots any deficiencies? But in which sense is mathematics like a language? I am not so much talking about formal mathematical language with words like “numerator”, “square root” and “Pythagoras” but, rather, the way we observe and make sense of mathematical situations by talking about them. Let us consider this in relation to a familiar piece of mathematics:

$$\begin{array}{r} \mathbf{431} \\ \mathbf{-\underline{145}} \end{array}$$

How could we talk about this? When I was at school I did this sort of thing as follows:

“Can’t take 5 from 1 so you put a little one there and make that 11 but since you borrowed you have to pay back”, etc. This is mathematics in the hands of a non-native. I was doing mathematics but did not know what sort. But, since it worked, did it matter that I did not understand it? I later learned that this method was called the “Equal Additions” method. I showed this to some undergraduates recently and they found it bizarre. More recently the “Decomposition” method had its own 15 minutes (or was it years?) of fame. But what if after lots of instruction children still cannot do such methods or understand the situations in which they apply? The particular question was chosen here as it was a test item in a small study carried out by Alistair McIntosh some twenty years ago (McIntosh, 1978). Even after a full primary schooling where numerical procedures figured prominently many children could still not get a correct answer to this. More disturbing was that a large number of those who did get it correct were unable to tell a story that demonstrated their understanding of situations in which the procedure would apply. These numerical methods, it seemed, were methods that neither made sense or succeeded in delivering a correct answer for many children. This led me to further questions. How much mathematical instruction in schools rests on children being able to perform such procedures? To what extent does that result in the loss of valuable thinking time? How much thinking time can we afford to invest in procedures that fail so many children even if they are taught? Meanwhile, can we afford the unfortunate affective consequences of such approaches? So many children dislike mathematics it seems because it comprises of procedures that make little sense to them. Also, how does focusing on such skills divert us from pursuing the capabilities that more meaningfully equip children in their subsequent lives?

HERMENEUTICS

A key theme of all of my work has been hermeneutics, the theory of interpretation. In this perspective mathematics is not about getting THE meaning - it is about making an interpretation. But what does making an interpretation mean? Gallagher (1992), in *Hermeneutics and Education,* categorises four forms of hermeneutics in relation to writer and reader and considers the analogy to teacher and pupil.

1. Conservative Hermeneutics

This involves a "re-cognition and re-construction of a meaning towards preparing the individual for common participation in the state, the church, free society, and academia" (Schleimacher, cited Gallagher, 1992, p. 213).

This is very much a traditional view on how children learn. The teacher teaches. Children try to understand what he or she means. Here there is no real scope for personal interpretation. 431-145 equals 286 and that is it, and you do it this way. The task is to get the teacher's meaning. Gallagher, however, offers three alternatives to this conservative approach:

2. Moderate Hermeneutics

Leading modern exponents of moderate hermeneutics are Gadamer (1962) and Ricoeur (1981). For these writers, whose work has included a strongly theological dimension, there are certain truths that orientate our way of seeing things. Gadamer's hermeneutics does not see tradition as fixed but, rather, sees it as being transformed through an educative process. There is a mathematics that shapes our understanding but as learners we bring something new to it; personalise it in our minds so that it becomes something unique to us. Moderate hermeneutics permits a range of interpretations, some of which may be seen as being closer to the truth. However, no interpretation is ever final. Hermeneutical understanding never arrives at its object directly; one's approach is always conditioned by the interpretations explored on the way. Language shapes the things we see. Whilst one's understanding may become "fixed" in an explanation for the time being such fixity is always contingent. In choosing to act myself, as if my explanation is correct, the world may resist my actions in a slightly unexpected way, which results in me having a new understanding, thus resulting in me offering a different sort of explanation, providing a new context for my actions and so on. This circularity between explanation and understanding, termed the "*hermeneutic circle*", is central to hermeneutic method. This might be seen as alternating between attention to the continuous flow of one's understanding and discrete encapsulations of this captured in explanations. In mathematics teaching we would see the ideas being presented as being processed through children's minds and, as a result, the ideas themselves are transformed. That is, they become more personalised, incorporated as they are into a more individualised schema. In mathematics education research constructivism is based around such a perspective. Let us look at the problem 431-145 and see what meanings we can bring to it and the alternative ways in which it can be understood. Factual it may be as a statement but it takes humans to interpret which situations to which it might be applied. Ricoeur is a theologian. For him there is a God but the existence of God depends how the individual sees God. Similarly, there is mathematics but it depends on how individuals see it, and language shapes what such individuals see.

3. Critical Hermeneutics (more commonly known as Critical Social Theory)

In this perspective education is seen largely as a transformative process, principally concerned with the "emancipation" of the student from the ideological structures that bind his or her action (e.g., Habermas, 1972). The educational process then might be seen as exposing the particular ideologies at work. In this perspective there would be certain socially inscribed conceptions of what mathematics is. The student might ask "why am I learning mathematics in this form?", "where is the teacher coming from in seeing mathematics in this way?" Here language does not just shape what we see – it distorts what we see and the educative task is to free us of that distortion.

As an example, in the early 80s I worked as a mathematics teacher in central London. There was a public mathematics examination designed specifically for London children. A particular question presented brief details of the American defence budget and also of the American AID budget. There was a big hoo-hah in the press. "How dare these left wing teachers do such a thing – it's just ideological. Mathematics should not be ideological like that". But surely the presentation of mathematics is always ideological. Is mathematics not always shaped around some conception of society with a particular social ideology? So often the agenda of mathematics education is compliance with current norms and this can often squeeze out alternative perspectives. Mathematics is often depicted as being sets of skills and procedures. Yet such depictions so often result in many people depicting themselves as failures. Surely such depictions are also ideological.

As another example, much recent press coverage attends to how countries compare with each other on specific skills. Mathematics has become internationalised and, in a sense, commodified as a subject in itself, shaped around certain caricatures of mathematical skills and procedures. As a result mathematics shapes its features around skills that are not necessarily relevant in contemporary workplace situations. Recent research by Noss and Hoyles (Hoyles, Wolf, Molyneux-Hodgson & Kent, 2002) argued that traditional mathematical skills as learnt in school do not feature greatly in the workplace (e.g., civil engineering, nursing) and that systemic skills of making sense of situations are far more valid. "One size fits all" mathematics does not serve us well generally it seems.

4. Radical Hermeneutics (more commonly known as Post-Structuralism)

> All my books...are, if you like, little tool boxes. If people want to open them, or to use this sentence or that idea as a screwdriver or spanner to short-circuit,

> discredit or smash systems of power, including eventually those from which my books have emerged ... so much the better. (Foucault cited in Patton & Meaghan, 1979, p. 115)

As a reasonably numerate member of society I have not employed in adult life many of the mathematical skills my teachers offered to me at school. But that is not to say the education was not useful – just that the ways I have made use of it have been unpredictable – I have done my own thing with it. I made sense of it and used it in my own way. This seems to be Foucault's approach – it is not for the teacher to prescribe how children subsequently use the things shared in his or her teaching. The children are free to make their own sense and if they show the errors in the teacher's thinking, so much the better. If the children have spent time learning certain procedures for calculating 431-145 it may be that they then realise that mathematics can be better understood or anchored in different ways.

Another leading writer regarded as post-structuralist is Derrida. Derrida's work (e.g., Derrida, 1994) suggests that since long ago we have been describing the world in such a way that our way of describing has taken on a life of its own. We always end up describing previous descriptive structurings. Within more traditional hermeneutics (e.g., Ricoeur, 1981), although we can build a picture of reality, we can never access this reality directly; language always intervenes. Derrida, meanwhile, has a more ambivalent understanding of reality since, for him, reality is meaningless without the linguistic layer, created as it is presently but according to inherited categories. For example, Derrida has discussed how our understandings of the present are conditioned by the media through which we receive depictions of it. He claims that actuality is *made* and that virtuality (virtual images, virtual spaces and, therefore, virtual outcomes) is no longer distinguishable from actual reality. "The 'reality' of 'actuality' – however individual, irreducible, stubborn, painful or tragic it may be – only reaches us through fictional devices"(Derrida, 1994, p. 29). Derrida's response to Baudrillard's more extreme stance is encapsulated in the paper, "The gulf war did not take place"(Baudrillard, 1995). There Baudrillard argued that the war as understood by most people became a media event largely unhinged from the suffering of the participants. It was the media event that shaped people's understanding of the war rather than the war itself.

We may ask how mathematics has become mediatised? What makes mathematics newsworthy? How does this shaping for consumption reshape how mathematics is understood? So often our actions are a response to the headline that we are not performing well enough in mathematics and how we might correct this. And school mathematics itself is shaped in response to such headlines. The league tables derived from the *Trends in Mathematics and Science Study* (TIMMS) carried out in the USA to compare its performance with other countries have figured prominently in this mediatised version of mathematics and have resulted in governments in other countries shaping policies in education with a view to improving their countries' league table performance.

In these questions we are asking what mathematics has become. There is not a truer mathematics hiding behind any more. Unlike the critical perspective where we try to correct distortions – here we acknowledge that things have changed and that we need to adjust to new ways of seeing things.

In mediating between these four positions, what sorts of factors should we take into account? At an institutional level how might we understand the purpose of a mathematics curriculum? Within the four frames pinpointed by Gallagher the curriculum could be read, respectively, as:

- an outline of mathematics as a discipline,
- a guide for mathematical learning by children,
- a cynical ploy to make teachers and children more accountable according to a particular institutionalised account of mathematics, or
- a reconfiguration of the discipline itself to meet contemporary needs.

No one, however, could sit down and decide which of these would prevail. Rather, such distinctions could be made only in after-the-fact interpretations. Yet the choice between such interpretations would in no sense be resolvable. It would always necessarily be subject to ideologically-inspired assessments. There is no final answer to the question of "what is mathematics"? We are always free to decide differently what our needs are in the area. Nevertheless, we shall now turn to some illustrations of how mathematics is understood and works for some children and some teachers.

WHAT IS MATHEMATICS?

Let us instead consider two rather unusual perspectives on what mathematics might be seen as being, to shed light on how we might tackle this problem of what is mathematics. Rather than making assumptions about what mathematics should be, let us instead look for evidence of what it is understood as being in certain situations in the classroom and think back from there. Firstly, how might children see mathematics? What do they emphasise? I want to offer an anecdote about two ten-year-old boys demonstrating various skills in a game of "Multiplication Snap"(Brown, 2001). The story provides just one account of children involving themselves in a mathematical activity. But what can we learn from it? Can we get a sense of how the children understand the particular task?

Each had a share of playing cards and took turns to place a card on a central pile. My understanding of the teacher's intention was that if the product of two successive cards was in the range of 20 to 40 the first person to say "snap" collected the central pile. The game finished when one player ran out of cards.

It soon became clear that if I placed too much concern about what the teacher had in mind I would be distracted from what was really going on. To suggest that adherence to the teacher's rules would optimise the use of skill would be to ignore a considerable range of talents on offer. A variety of strategies assisted the boys towards winning the game. The boys' attempts to create the appearance of winning seemed to be governing much of what followed.

One of the key strategies was to slap a hand on the table each time a new card was placed on the central pile. Invariably, the boy placing the new card had most success with this since it arose prior to any detailed concern about whether or not the product of the two numbers was in the required range. There was no shame in asserting an incorrect pair. Rather, it displayed confidence and engagement.

This ritual persisted throughout the game although as time progressed more obvious pairings, such as two picture cards which scored 10x10, escaped the slap. Whilst the initial slap often appeared as a demonstration of absolute certainty both players saw through this. On each occasion the successful slapper reluctantly withdrew his hand if confirmation was not forthcoming in the following few seconds, to make way for "reflection".

The ensuing period of relative calm permitted the search for some sort of justification – calculators appeared, jottings took place, friends were asked and searching looks were directed towards me whilst I sat in the corner pretending to be an invisible researcher. This process of validation was full of tension and any half baked notion was worthy of an airing, if only as a holding device. After all, it would appear from the play that any concern for your partner's ideas distracted you from coming up with your own. Each new declaration was preceded by a renewed slap of the hand on the central pile with varying degrees of decisiveness. Degrees of certainty seemed to displace any sort of right/wrong dichotomy. Uncertainties were often resolved by the loudest granting themselves the benefit of the doubt.

On closer inspection quite a few other strategies, worthy of any school staff meeting, were being employed. These included: slapping a hand down as soon as it appeared the opponent was about to slap; offering new interpretations of the original rules; proceeding rapidly through controversial decisions; bluffing; claiming ownership of arguments offered by the opponent; and blatant cheating such as changing the order of cards on the central pile.

The quest was to convince others rather than to be correct and it was important to present a good case regardless of whether or not you had grounds for actually thinking you were right. The pressure was on to offer convincing arguments and there was no teacher immediately available to offer any final confirmation.

The mathematics was inseparable from the social activity that generated it. In social situations generally, negotiation skills and the ability to appear correct are often as important as actually being correct. One might suggest that modern day economics, for example, has less to do with statistical facts than with assertions of particular interpretations. For example, a finance minister in the United Kingdom was once sacked for lacking the required political aptitude to supplement his economic skill. Working through various financial claims from finance companies is an adult activity requiring mathematical skill but it is also necessary to understand how the companies are seeking to pull the wool over your eyes. The children's actions seemed to be shaped around an alternative interpretation to the teacher's of what was important in the activity. Perhaps the children were not wrong in their assessment. Mathematics is an interpretive activity. It is in a sense always embedded in some sort of social activity. It is only ever needed in some sort of social activity. I suggest those skills of interpretation, those skills of problematising and interpreting situations, need to be built up alongside mathematics itself, if indeed it is any longer possible to separate mathematics out from its social embedding in that way.

A PERSPECTIVE OF SOME NEW TEACHERS

What about teachers? How do they see mathematics? I will offer some examples shortly but I first need to explain the context in which their statements arose. I directed two studies funded by the UK Economic and Social Research Council (ESRC). The first study focused on the four years of Bachelor of Education (B.Ed) training (Brown, McNamara, Hanley & Jones, 1999). The second study focused on the transition from the fourth year of training to the first year of teaching. The cumulative report has recently been completed (Brown and McNamara, 2005). The particular aims of the studies that are of relevance to this address were:

1) To examine how the students'/teachers' conceptions of school mathematics and its teaching are derived, and
2) To examine the impact that government policy initiatives relating to mathematics and Initial Teacher Training, as manifest in college and school practices, have on the construction of the identities of the primary students and first year teachers.

The studies were situated in the B.Ed. (Primary) programme at the Manchester Metropolitan University in the UK. The empirical material produced provided a cumulative account of student transition from the first year of training to the end of the first year of teaching. The first study spanned one academic year and included interviews with seven or eight students from each year of a four-year initial training course from a total cohort of some 200 students. Each student was interviewed three times at strategic points during the academic year; at the beginning of the year, whilst on school experience and at the end of the year. The study took the form of a collaborative inquiry between researcher and student/teacher, generating narrative accounts within the evolving students/teachers' understanding of mathematics and pedagogy in the context of their past, present and future lives. The second study, which followed a similar format, spanned two academic years. In the first year of the study a sample (n=37) of fourth year students was identified. Each student was interviewed three times during this year. The sample included seven students involved in the earlier project, five of whom were tracked for a total of four years. In the second year of the study a small number of these students (n=11) were tracked into their first teaching appointment. Each of these students was interviewed on a further two occasions. These interviews monitored how aspects of their induction to the profession through initial training manifested itself in their practice as new teachers. A particular focus was on how aspects of the college training continued to influence the new teacher's practice in school, with an emphasis on mathematics teaching practice.

Specifically, the body of students that the research focused on were those who were training to be primary teachers and, as part of their professional brief, would have to teach mathematics. Significantly, whilst all the students that were interviewed held a GCSE (16+) mathematics qualification as required for entry to college, none had pursued mathematics beyond this. Nor had any of the students elected to study mathematics as either a first or second subject as part of their university course. The research set out to investigate the ways in which such non-specialist students conceptualise mathematics and its teaching and how their views evolve as they progress through an initial course.

The studies coincided with some major reforms of teaching and teacher education and this coincidence allowed us to include an examination of the impact of these policies. The reforms included the following UK policy instruments related to primary mathematics:

For schools	National Curriculum National Numeracy Strategy Standardised Attainment Tests Standardised training programme Government Inspections
For training colleges	National Curriculum: Initial Training Numeracy Skills Tests Government Inspections

Specifically, the key features of the *National Numeracy Strategy* are:

- *An emphasis on calculation, especially mental calculation,*
- *A three-part template for daily mathematics lessons,* starting with 10-15 minutes of oral/mental arithmetic practice, then *direct interactive teaching* of whole classes and groups and, finally, 10 minutes of plenary review;
- *Detailed planning using a suggested week-by-week framework of detailed objectives,* specified for each year group; and
- *A systematic and standardised national training programme,* run by newly appointed local consultants using videos and transparencies to demonstrate "best practice" (as described by Brown et al., in press).

The key findings from the two ESRC studies were as follows:

- Most primary teachers found mathematics in their own schooling to be a real problem.
- They were, however, convinced by alternative ways of seeing mathematics at university during their teacher training.
- Nonetheless, once school placements featured more prominently within the training, many other demands impacted together with the return of some more traditional conceptions of teaching mathematics.

Let us consider a particular hypothetical student and see what this process looks like. Karen is a trainee teacher in her final year of training. She is very aware of a multitude of demands that she faces. Apart from meeting university requirements she will also need to fit in with the expectations of the school where she will be placed in her final year. She may face some additional scrutiny from government inspectors. She may well wish to be popular with children and their parents. She will be teaching up to ten curriculum subjects including mathematics, our particular concern. She will need to build an enjoyable conception of mathematics, whilst following the mathematics curriculum adequately. She will need to minimise anxieties that pupils feel towards the subject and perhaps, as we shall see, attend to some of her own anxieties in this direction. During this year she will face a formal test of her mathematical knowledge. Over and above all of these demands she may well hold on to some of her own personal aspirations with regard to her chosen profession.

She does in a sense lose touch with her own voice. But what else gets squeezed in this surfeit of demands? Let us look at some examples of teacher speech:

> Right, well the mental starter was just I demonstrated to begin with and then they, the children, came up and it was interactive, they actually had to move the numbers in pairs then the main part of the lesson started off with questioning, introducing the ideas of the data, demonstrating the frequency chart and then each child had a white board and they had to write their favourite subject on the white board, then I collected the

information so this was all whole class with them on the carpet – collected the information put it onto a class frequency chart and then the children – so I demonstrated really – then the children went into the four groups and did it themselves with me working between the groups and stopping them now and again just to clarify any corrections arising or problems and then it was the whole class plenary when the children present – the children themselves then presented their findings to the rest of the groups.

In this extract I offer an account of a teacher that was wholly typical of the material we gathered from some 200 hours of interviews with trainee and new teachers. Despite making strenuous efforts to persuade the teachers to discuss the mathematical aspects of their work we did not succeed in this objective. It would appear that a key victim amidst the various demands was a more explicitly mathematical account of the mathematics teaching being carried out. In the following extract I offer one of the most explicitly mathematical examples that we collected:

> I think it was the ways in which we work out multiplication or something; for example we got the 2 x 8 and the 5 x 5, you know, we did it the other way round and I think it was the reversal – I'm trying to get the children to see that 6 x 4 would produce the same answer as 4 x 6 because that's work of the lowest ability group so that, I mean, we moved on actually to breaking it up into 3 different parts so we might have a 2, a 5 and a 3 in the box – would the answer be the same as if we had 5, 3 x 2 – do it in a different way – because a lot of the children at that time, their concepts would – were that it would have to be a completely different answer and maybe because we were starting with the 5 then they could see that if we – if you had, for example, 5 x 3 just started it was 15 but on the other hand you had 2 x 3 then the answer was 6 so they thought that that was going to be a lot less then it's – if you did it in a different way, so ... I think that's what it was, you know, the reversing of the multiplication, does the answer still work out ...

What skills do teachers need in maths? When asked this question, again mathematics did not figure highly in the responses. For example:

> I like to give as much support as possible in maths because I found it hard, I try to give the tasks and we have different groups and I try to make sure each group has activities, which are at their level. Because of my own experience.

> The first one that springs to mind which I believe that I've got and which I think's very important, particularly in maths as well, would be patience.

What sense do we make of such data? One issue with this research does concern the importance of reflection. Rugby players are not necessarily better at rugby if they can talk about what they are doing. Is this also true of teachers? How much does teacher knowledge depend for its efficacy upon reflective knowledge being built into it – a reflective knowledge that can be articulated? Whatever we may think, our data from some 200 hours of interview demonstrates that we failed to persuade student teachers and new teachers to talk explicitly about the mathematical aspects of their teaching. They talked about its organisation and its regulation but any reference to mathematical content and associated objectives was always fairly minimalist.

So I have presented two alternative pictures of what maths might be regarded as in the classroom. The child's view was governed by many seemingly non-mathematical concerns. The teachers' views were more a function of administrative procedures. The child's view may not be typical but the teachers' views, at least amongst student and new primary teachers, is perhaps more typical, at least on the basis of the studies. There is often an assumption that there is a correct version of mathematics to which we should aspire. Neither of the two accounts seem to be in line with that. In a traditional sense both are missing mathematics itself. Yet perhaps there are some alternatives to seeing a singular trajectory to such a supposedly correct view. How might we include and work with such alternative views?

WHAT IS RESEARCH IN EDUCATION?

At the recent opening of a research centre at the University of Waikato, the Dean of the School of Education, said that it is important that the university remains a place where questions are asked. The Minister of Education who was also present argued that research does also need to provide answers. One would hope that this would be the case but what sort of answers might we be able to deliver?

Invariably research is shaped by financial constraints. This governs the types of research that can be carried out. Professor Ted Wragg, at his own professorial inaugural lecture at Exeter in 1979, spoke of how investment in research in the glue industry was many times greater than investment in education research. I wonder if this situation has changed. Education research is often down to individuals who do not have access to broad samples. Funding for larger projects is rarely sufficiently large to support a meaningful sample size. But what could we learn from them if we did have them? I shall look briefly at two studies carried out in other countries.

The TIMSS study mentioned earlier is probably the biggest study to have been carried out in recent years. The study was funded by the United States government to compare the performance of its schools with those in other nations. A great deal of policy in many countries has since been shaped around achieving better performance in these comparative league tables. But what sorts of information can this study tell us? With regard to what factors determine good mathematical performance, the study concluded "there is no simple answer – while each (variable) probably has an effect, none by itself made a major difference" (Beatty et al., cited in Brown et al., in press).

As an interesting side issue here, there is some evidence to suggest that whilst the UK did below average in "mathematics" it did well above average in "problem solving". Yet all efforts have been directed at improvement in "mathematics" which is perhaps the more prestigious indicator, at least in the media context. Meanwhile, those countries that achieved well in the TIMSS league table in some senses have curricula that are more narrow but specifically shaped around the skills being measured. The evidence that the policy changes in the UK have been successful in "mathematics" is very weak as recent headlines report, following the one million UK pound Leverhulme Numeracy Research Programme (Brown et al., in press):

> A £400m failure. The national numeracy strategy has made very little difference to pupil attainment, research shows. THE flagship government programme to transform maths teaching in primary schools has done little to raise standards despite costing £400 million. -The scores of the least able were actually worse. (Mansell & Ward, 2003, p. 11)

There is also some limited evidence that this change of emphasis has resulted in a reduction of problem solving skills. The intended control technology has been pervasive yet, in this instance, it seems not to have had a dramatic effect following policy changes made as a result, even if the picture that guided it was in fact correct.

But did it in fact guide us to the most important issues? Are we now to be governed by such headlines or the research underlying it?

Meanwhile in the UK the Leverhulme Numeracy Research Programme (Brown et al., in press), which led to many of the recent headlines, also sought to explore the factors that contribute to good mathematics teaching. Teacher questionnaires were used in analysing mean gains against a range of variables across years 4 and 5 of primary education. These focused on biographical data (e.g., level of mathematical qualifications, years of experience, appointment to co-ordinator post) and pedagogical factors (e.g., frequency of access to calculator, frequency and type of homework set). Again, as with TIMSS, there appears to be no clear conclusion: "No variable has been statistically significant across both years, and only a handful have reached significance in either year" (Brown et al., in press).

The picture simply is not a clear one. An overview with a clear consequential strategy seems to be an unlikely result of such research investment. Large research projects in mathematics education are rare and, in the two instances described, the results have proved ambiguous in terms of possible strategic implications. Also, the constructions of such overviews, as in the UK, can lead to policies that tell teachers what to do without involving them in the decision. Meanwhile, with the apparent failure of major policies to have a clear impact in the UK, we might question the purpose of this control apparatus as an effective approach to improving mathematics teaching, at least in the terms that were intended. The policies have not worked well in terms of changing results and the cost seems high in terms of teachers being left out of the decision-making process. Suppose, however, hypothetically, that we were to get an accurate picture of how mathematics teaching might be improved in schools. Could we implement such an approach? To succeed would surely also suppose that teachers would understand it in the required way and that they could make the necessary changes to their practices. Perhaps, however, teachers have their own views and would prefer not to understand it in the required terms. They may also require significant training to make substantial changes to their practices. Idealism shapes a lot of our policy-making, as does a supposition that we share ideals. The strategy of aiming at an ideal arguably has a poor track record. I do not believe that I am being pessimistic – simply pointing out that perhaps we need to re-conceive our notions of what progress is.

Is it helpful to see the process of our collective development in terms of grand solutions that can be applied universally? I fear that we might always be disappointed with the results of a process so defined. We are still trying to raise standards a good few years after we first started to try but is there any evidence that we have made progress? Are we better now than we were in the forties, the sixties, the eighties, or the nineties? Does anyone actually know? And if so what do they know? Certainly the features that we seek to compare are constantly on the move. Mathematics is different now to what it was then – our needs are different. Mathematical skills and their relative importance are constantly being revised – for example, key school components in the sixties are not seen as so important now.

Can research be done meaningfully by teachers with children in their classes? Big scale research and policy initiatives cannot always do the job even if they do make accurate assessments of the situation we face. We will, however, always need to place faith in teachers and their capacity to execute policies and curriculums in an effective fashion. How can we involve them in an alternative style of research? This would not have to be a grand scale of research with universal answers but rather a serious engagement with curriculum development issues. It seems to me that we need to enable teachers to participate in developing understandings of how we might see mathematics in the classroom – rather than receiving a curriculum as something to be implemented, constructed by people outside of the classroom. Can we not instead work with a framework that allows teachers to participate more fully in curriculum evolution? In so doing might we be able to activate the practice of skills that are so important, alongside the commodified skills and procedures that have become to be known as "mathematics"? For this reason I suggest that we need to be attentive to how teachers hold on to their own professional voices and how they protect their professionalism.

The New Zealand Numeracy Development Project

The New Zealand *Numeracy Development Project* (NDP) is presently providing a good framework for teaching mathematics in schools in New Zealand. I believe, however, that it is important that it does not become a policing structure that takes evaluative responsibilities away from the teachers themselves. In my view it is important to prevent teachers becoming mere civil servants of the latest government ideology and, rather, to offer a structure that enables teachers to exercise real professional autonomy. This is akin to the framework that is presently in place. I believe that we need to enjoy it as it is and not destroy it in the name of questionable control technology designed to regulate it. Good advice does not always work so well if it is converted into a policing structure.

The NDP is currently resisting "one size fits all" mathematics. It is still governed by a philosophy that sees mathematics as being about questions like: How do you see this? How does your way compare with my own? Do the two of you agree? The risk I see is that if assessment gets too closely tied in with the staging present within the scheme, new algorithms will emerge – akin to Equal Additions or Decomposition approaches to subtraction. The NDP is not (yet) as all-embracing as its UK equivalent – but one interpretation is that it is on the same trajectory into the future.

The NDP is clearly influenced by some major traditions in mathematics education. Two particular figures are especially visible. The first is Jean Piaget who has been so influential in mathematics education internationally, most recently through his impact on constructivism, which is probably the most dominant research perspective lately. This influence impacts on the NDP in the way in which alternative student perspectives are encouraged. It also underpins the stages through which child mathematical development is understood. Another figure, however, is also very present. His name is Caleb Gattegno. Gattegno translated Piaget's *Child's Conception of Number* in the fifties; the book that was to have so much influence on mathematics teaching. Gattegno did a great deal in promoting the book and, in many senses, is the person who introduced Piaget to mathematics educators. Gattegno's methodology in mathematics teaching was very visible in the materials of the UK *Association of Teachers of Mathematics* throughout the sixties and seventies. It is this approach that now dominates the NDP. Gattegno himself, however, turned away from Piaget, arguing that many aspects of his influence could backfire.

Piaget's influence could, he said, "easily lead to the disappearance of empirical attitudes, more experimental moods and constant watchfulness, to be replaced by the mediaeval criteria of Authority and Opinions" (Gattegno, 1963, p. 3). He added that the empirically minded Anglo-Saxons see in the tidy set of stages the germ of the psychological equivalent of their syllabus: "They also see how easy it would be to prepare tests on such bases" (Gattegno, 1963, p. 3).

The NDP follows Gattegno's procedures yet also organises them into stages, an extension that Gattegno himself explicitly rejected in his own approach, primarily because such a structuring leads to testing that can restrict the scope and purpose of mathematics teaching. Thus far the NDP has stopped short of such testing. Recent BBC news reports emanating from the UK offer a warning about the consequences that could arise from taking that next step:

> Primary school tests are to be reformed amid concerns from parents and teachers that they cause too much stress… The Education Secretary has announced wide-ranging changes to the way seven year olds in English schools are tested. *It's intended to give more control back to teachers.* The opposition are saying it's a massive climb-down from the tests and targets regime on which so much of education policy has hung these last few years. If they've recognised it doesn't work in primary schools, why not elsewhere? (Newsnight, 2003, my emphasis)

We can instead advocate that teachers take the lead at this stage. I believe that teachers need to be given a bit of space to make their own judgements whilst being provided with the support and in-service training that might better enable them to make such judgements. Little of value is achieved by policing them too heavily. Teachers need to be encouraged to develop their own voices. That, I believe, works rather more effectively than externally defined regulation.

To return finally to the title of this lecture – making mathematics inclusive – mathematics needs to include teachers as well as children. School mathematics is made in the classroom not outside. It needs to be created together by teachers and children. They will fail if they are always trying to get it right in someone else's eyes.

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