A STUDY OF THE IMPACT OF MATHEMATICS RECOVERY TRAINING ON TEACHING STAFF'S CONSTRUCTS ABOUT THE TEACHING AND LEARNING OF NUMBER

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I certify that all material in this

Thesis

Which is not my own work has been identified and that no material is included which has been submitted for any other award or qualification.

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ABSTRACT

This study focuses on how the experience of training in Maths Recovery affects staff constructs about the teaching and learning of number. The Maths Recovery programme is a well-established, research-based training programme, which takes a constructivist approach. Staff in C (a Local authority in the UK) are offered a Maths Recovery course which takes place over two terms and involves taught sessions, tutorial work and ongoing assessing and teaching of pupils in their own schools.

The study uses the methodology of Personal Construct Psychology (George Kelly, 1955/1991) to investigate and make explicit the constructs about the learning and teaching of number of a group of Maths Recovery trained teaching staff. Through the use of a donated construct, 'teaches numeracy very well', the staff constructs are used to create a list of constructs which the staff feel are associated with good numeracy teaching. This list of constructs is compared with the declared principles of the Maths Recovery programme, and conclusions are drawn about how effective the Maths Recovery training has been in helping staff to adopt these principles. Results show that the constructs generated by staff do reflect the Maths Recovery principles, but that there are some gaps: staff constructs tend to be about changes to their actual teaching practices, rather than changes to their philosophy of teaching. There is a discussion about how the radical constructivist principles underlying the Maths Recovery programme seem to be difficult for staff to adopt or articulate. This includes how future Maths

Recovery courses might support staff to be more reflective, and to move more towards constructivist approaches.

In the second phase of the study, the generated staff constructs, together with some constructs derived directly from the Maths Recovery Principles, are used to formulate a questionnaire. This questionnaire is used at the start and end of a subsequent Maths Recovery course, to enable participants on the course to reflect upon the changes which they have made in their thinking about the teaching and learning of numeracy. It is found that staff are able to make use of this questionnaire as a reflective tool, and that they respond positively to the items about philosophy as well as to those about teaching practices. Some ideas to develop the reflective use of the questionnaire further are discussed. It is also found that, following their Maths Recovery training, many staff have become more constructivist in their outlook: they are more likely to see themselves as skilled facilitators of pupils' mathematical understanding, rather than just as instructors in numerical procedures.

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CHAPTER 1
INTRODUCTION: BACKGROUND TO THE STUDY

1.1 MATHEMATICS RECOVERY IN CUMBRIA

This research arose from reflecting on some ongoing work in Cumbria's Education Department, consisting of the training of teaching staff in the Mathematics Recovery approach. Mathematics Recovery, which was developed from research studies into children's numeracy development in the 1990s, is an early intervention programme in numeracy, which has comprehensive assessment materials together with detailed teaching procedures. The programme, which will be described in more detail in the next chapter, is based on a constructivist approach to supporting children's conceptual development in the area of numeracy. (See Wright, Martland & Stafford, 2006a and Wright, Martland, Stafford & Stanger, 2006b.) In Cumbria so far, over 300 teaching staff (a mixture of teachers and teaching assistants) have been trained, in over 200 schools, including those in the primary, secondary and special sectors.

Maths Recovery training, as being implemented in Cumbria, involves both trainees and trainers in a considerable investment of time. Courses take place over two terms, with the first term focusing on assessment, and the second term on teaching. Throughout the course, the emphasis is on trainees acquiring and practising skills to work with children: as well as having direct tutorial support in their schools, they videotape their assessment work with pupils, and receive tutor feedback on this. They also carry out an individual teaching programme with a pupil, consisting of 18 half-hour long teaching sessions. After successful completion of the course, teaching staff are able to apply for funding to carry out further teaching programmes, with pupils who are experiencing difficulties in acquiring numeracy skills. Given the high level of resources which Cumbria is devoting to this programme, it has been considered very important that the work should be evaluated.

1.2 EVALUATION OF MATHEMATICS RECOVERY IN CUMBRIA TO DATE

Evaluation of the training so far has been carried out in various ways:

- Trainees give feedback to the training team, through feedback sheets after each taught session.

- There is rigorous assessment of the skills which trainees have acquired by the end of the programme, through checking whether trainees' videotapes demonstrate the key skills specified in the MR programme.

- Pupils who receive a Maths Recovery programme have their numeracy skills assessed at the start and end of the programme. Progress is seen through changes in criterion-referenced descriptions of their skills, and is measured as movement through the levels and stages of mathematical development, which were defined in the research underlying the programme (Wright et al, 2006a).

- To check on longer-term progress and on whether the pupils' new skills have generalised, analysis of the Standard Assessment Tasks (SATs) which pupils take in Year 2 and Year 6 is planned. It will be possible to compare results for pupils who received individual MR programmes with those for a matched group who did not.

1.3 NEED TO EVALUATE OTHER ASPECTS

Evaluations so far have been positive, but the training team feels that trainees and pupils benefit and develop in other ways, not captured by the above evaluation methods. Teaching staff report that pupils who complete MR programmes gain hugely in confidence, both in numeracy and often in other subject areas as well. Staff also recount that, inspired by the training, they make significant changes to their classroom teaching, and that they feel they have become much more effective as teachers of numeracy. Several of them have referred to changes in their understanding of how pupils learn number, and to what their role as a teacher of numeracy should involve. Evidence for any such changes in staff, however, has so far existed only at an anecdotal level.

The evaluation which was built into the delivery of Maths Recovery in the Local Authority, and which is continuing as successive cohorts of staff are trained, followed the usual practices within the Local Education Authority. This was to use questionnaires to assess trainees' satisfaction with course sessions, supplemented by evaluation methods specific to the particular course. In the case of Maths Recovery, those methods consisted of assessing the skills gained by the trainees, and assessing the gains made by the pupils who were taught by the trainees. Muijs and Lindsay (2008) describe a broader range of possible levels at which the Continuing Professional Development (CPD) of teachers can be evaluated. They describe a hierarchical model of six levels of evaluation, adapted from the five level model of Guskey (2000). The six levels are:

Level 1: participants' reactions

Level 2: participants' learning from CPD

Level 3: organisational support and change

Level 4: participants' use of new knowledge and change

Level 5: student outcomes

Level 6: cost effectiveness

For Maths Recovery in Cumbria, the evaluations so far had focussed on level 1 (course questionnaires), aspects of level 2 (tutors assessing participants' performance), level 5 (data on pre and post testing and SATs) and level 6 (through management and budgeting arrangements). Levels 3 and 4 were supported through the ongoing work of the Numeracy Consultants in schools, but not explicitly evaluated over a period of time following the course: it had been judged to be too difficult to separate out the effects of MR training from those of other concurrent changes in resources and in national requirements for maths teaching. Another significant gap in the evaluation was in the aspects of level 2 which are concerned with values, affective outcomes, and motivational and attitudinal outcomes – and the changes which the tutors had informally noted, as described above, were largely in these domains. This author therefore sought an evaluation method which would be able to capture such changes, and would also give the participants the opportunity to reflect on how they have used their new knowledge in the context of their school.

The current proposal, therefore, set out to explore the impact which MR training has had on staff's constructs about the teaching and learning of number. This author holds that such an exploration is potentially valuable, in two main ways. Firstly, it could enable the tutors to adapt their future training, so as to try and target key constructs which seemed not to have changed much in response to the training. Secondly, in so far as the exploration of staff constructs is shared with the staff concerned, it may cause those staff to reflect upon their own practices, and to continue to develop and implement their ideas. This would be wholly in the spirit of the 'reflective practitioner' stance, which is required of them professionally, and supported by research into effective teaching (for example, Spilkova, 2001, Goodell, 2000).

1.4 OUTLINE OF CURRENT STUDY

Firstly, the author will describe the decision to use the methods of Personal Construct Psychology (Kelly, 1955/1991) to explore the constructs which teaching staff had about the teaching of number. In a pilot phase, the author worked with six staff who were about to participate in Maths Recovery training, in order to decide upon the details of the interview method for the main study. This resulted in decisions about what elements to use in the interviews, how many constructs to elicit, and when to interview the participants.

The main study, which was conducted with eleven teaching staff after they had completed their Maths Recovery training course, will then be described.

This study involved interviews with the eleven staff, and opportunities for them to receive and comment upon feedback. The 'elements' chosen for use in the interviews enabled the staff to compare themselves before and after the Maths Recovery training, on a number of aspects of their teaching. By including a donated construct , 'teaches numeracy very well', in all of the interviews, it was also possible to pool the resulting constructs, creating a list of shared constructs about good numeracy teaching.

The study will then describe how this list was subsequently used as the basis for a questionnaire, which was designed to be used by other teachers as a tool to help them reflect on the quality of their teaching. The questionnaire was piloted with a further group of teaching staff who were just completing their Maths Recovery training. Ideas for further developments in the use of the questionnaire will be discussed.

Further details of the rationale and methodology for the study will be given in Chapter 3 below, together with the specific questions which guided the research. But first, in order to give a firmer theoretical background to the study, some relevant research will be reviewed in Chapter 2.

CHAPTER 2
LITERATURE REVIEW

2.1. INTRODUCTION

The current study draws on literature from several different areas. First comes a more detailed look at Mathematics Recovery itself and the underlying theoretical research. Secondly, there is an examination of some theories of how learners acquire mathematical knowledge, especially constructivist and problem-based approaches, and of how these are embodied in the Maths Recovery programme. Thirdly, some relevant research into teacher development is examined. Finally, there is a discussion of some research methods which have been used to explore teacher constructs. This chapter critically explores literature from each of these areas, drawing out issues which are salient for the study, and which influence the design of its methodology. This will lead on to the formulating of aims and specific research questions, in the next chapter.

2.2. MATHEMATICS RECOVERY

The theory and research basis behind the MR programme is outlined in Wright et al (2006a) and Wright et al (2006b), and in Willey, Holliday & Martland (2007). The programme is grounded in research into how children's numeracy knowledge develops, based on work by Steffe and colleagues (e.g. Steffe & Cobb, 1988 Steffe, von Glasersfeld, Richards & Cobb, 1983), which entailed tracking the progress of cohorts of individual pupils over a two year period (e.g. Wright, 1991; Wright, 1994; Mulligan & Mitchelmore, 1997). This tracking consisted of the making and systematising of detailed observations, through the analysis of video recordings of individual pupils working with each other and with staff. The process is similar to that used in studies using the microgenetic method (Granott & Parziale, 2002; Siegler & Crowley, 1991), where dense observations are made over a short period of time during which cognitive restructuring is occurring. This method enables direct access to the process of change, with a strong focus on "the 'how' of development and learning, on giving explanations" (Granott & Parziale, 2002, op cit). Wright and colleagues looked in detail at the effect of interactions between individual children and staff during short periods of successful learning, and were able to identify staff behaviours which were seen to facilitate children's learning within a session. They systematized these into nine 'Guiding Principles of MR teaching', which are discussed below (Wright et al, 2006b, pp 25-31). These principles can be seen to locate Maths Recovery firmly as a Radical Constructivist teaching approach, as will be seen from the discussion of Constructivist theories and their implementation in MR, below.

Wright and colleagues also analysed in detail the course of learning for all the individuals within the cohorts of children in their studies, and were thus able to identify some key stages in the learning of number skills, which the vast majority of the children went through. These were then defined as being the Stages in Early Arithmetic Learning (SEAL), which were subsequently used to organise teaching programmes within MR and to assess children's progress (Wright et al, 2006a, 2006b). The SEAL stages can be summarised as follows:

Stage 0: Emergent counting. The child cannot count visible items. The child either does not know the number words or cannot co-ordinate the words with the items.

Stage 1: Perceptual counting. The child can count perceived items but not those in screened (i.e. concealed) collections. This may involve seeing, hearing or feeling items.

Stage 2: figurative Counting. Can count items in a screened collection, but counting typically includes what adults might regard as redundant activity. E.g. when presented with two screened collections, told how many in each, and asked how many in all, the child will count from one, instead of counting on.

Stage 3: Initial Number Sequence. Child uses counting-on rather than counting from one, to solve addition or Missing Addend tasks (e.g. 6 + ? = 9). The child may use a count-down-from strategy to solve Removed Items tasks (e.g. 17-3 as 16, 15, 14 – answer 14) but not count-down-to strategies to solve Missing Subtrahend tasks (e.g. 17-14 as 16, 15, 14 – answer 3).

Stage 4: Intermediate Number Sequence. The child counts-down-to to solve Missing Subtrahend tasks. The child can choose the more efficient of count-down-from and count-down-to strategies, to suit the numbers in a particular question.

Stage 5: Facile Number Sequence. The child uses a range of non-count-by-ones strategies. These involve procedures other than counting by ones, but may also involve some counting by ones. In additive and subtractive situations, the child uses strategies such as compensation, using a known result, bridging through ten, commutativity, subtraction as the inverse of addition, awareness of the 'ten' in a 'teen' number.
(Adapted from Wright et al, 2006a, p 22.)

The reliability of defining these particular stages has been confirmed by further research, using much larger numbers of pupils, in the Australian Early Numeracy Research Project (ENRP). One aspect of this project was to conduct 20,000 assessment interviews with infant-aged children, tracking their development across one school year (Clarke et al, 2002; Gervasoni & Sullivan, 2007), and confirming that the usual course of the children's mathematical development and understanding is indeed as described in the

MR Stages in Early Arithmetic Learning.

There is also a body of research which evidences the effectiveness of the MR teaching programme (Wright, Stewart, Stafford & Cain, 1998; Wright, Cowper, Stafford, Stanger & Stewart, 1994; Phillips, Leonard, Horton, Wright & Stafford, 2003). Results of these studies generally show that when first grade (Year 1 aged) children who are underachieving in numeracy, as judged by teachers against curriculum expectations, are given daily individual MR sessions for about 10 weeks, around 75% of them meet or exceed curriculum expectations for their age, at the end of the programme. The measures used in these studies were the pupils' progress on MR assessments, with SEAL stage 3 or above being considered to be in line with expectations for Year 1 pupils. The National Curriculum framework for numeracy (DfES, 2001), used in England and Wales, gives progress statements for Year 1 pupils which are consistent with this assumption. However, the seven strands of the National curriculum cover a wider range of topics than does the MR programme. A full evaluation of pupil progress with MR would need to look at overall progress on the whole National Numeracy Curriculum, as well as longer term progress. As mentioned in the Introduction to this study, there are plans to track the long-term progress of Cumbrian pupils who have received MR programmes, through analysis of their National Curriculum tests. (As yet, there are not sufficient numbers of pupils who have received an MR programme and have also completed their Key Stage one SATs, to do this analysis meaningfully.)

The evaluations of Maths Recovery which are available so far have a main focus on pupil progress, and there is as yet little research into the issue of how Mathematics Recovery training might change teacher understanding or beliefs. One study which does explore the impact upon staff is that by David Hird, who evaluated the use of MR in one local authority, through semi-structured interviews with twelve MR-trained teachers (Hird, 2004). Interview questions in this study were quite open in nature, but did direct the teachers to consider and describe changes in particular areas: for example their own subject knowledge, and their view of how pupils had progressed. The study discussed interview responses in terms of how effective the interviewees perceived MR to be, and the support which they would need in order to develop the work further, and it made recommendations for taking the work further within the local authority. It did not attempt to look in detail at how teacher constructs might have changed through MR training, or whether such changes were in line with the intended outcomes of the programme.

The 'Count me in too' project evaluation of the work done in New Zealand (Thomas & Ward, 2001) also included a section on teacher change. Teachers answered questionnaires, and their responses were analysed by identifying recurring themes, and using particular teacher comments to exemplify these. However, the nature of the questions asked were such as to donate the themes (for example, 'has your content knowledge of maths been developed as a result of..........the project?') The project also did more detailed work with nine teachers, who were helped (through semi-structured interviews) to draw cognitive maps to illustrate the changes following training. This approach was more open-ended, although the main themes were still suggested by the interviewer. Changes to the teachers' professional knowledge were identified, with an increased structure and coherence showing in the maps they drew after training, as well as increased references to students' thinking, students' knowledge and aspects of pedagogy. The current study attempts to explore teaching staff's constructs in a more open-ended way than that used by previous studies, through the use of the more projective techniques of Personal Construct Psychology. Any commonalities between staff responses are then teased out through analysis of the data. In this way, it is hoped to avoid accidentally guiding staff to identify changes in the areas which the programme aimed to develop, but instead to cause staff to reflect on and describe how their construct system has changed.

2.3. MATHEMATICAL KNOWLEDGE, AND HOW LEARNERS ACQUIRE IT

2.3.1. Nature of Mathematical Knowledge

Before considering in more detail the literature on constructivist approaches to the teaching and learning of mathematics, it will be useful briefly to consider the nature of knowledge about numeracy. Research suggests that, for many teachers, mathematics is experienced as being a fixed, external body of knowledge, largely consisting of a set of procedures, which has to be transmitted as efficiently as possible to learners. (See, for example, Cooney, Shealy & Arvold, 1998; Thompson, 1992.) As Cooney (1999) says, this leads teachers to believe that good teaching involves 'good telling', avoiding causing students to experience stress in solving problems, and taking a role as 'the legitimizer of truth'. It is therefore clear that the beliefs teachers have about the nature of mathematical knowledge are critical in influencing their teaching practices.

Tirosh (1999) points out that there are many forms of mathematical knowledge, and that, in order to promote teacher development, we need to identify and characterize the forms of mathematical knowledge that are important for teachers to know. Importantly, it is not necessarily the case that a higher level of 'pure' mathematical knowledge directly increases teacher effectiveness. Murphy (2006) considers an audit of primary teachers' higher-level mathematical knowledge, and concludes that, whilst such knowledge may boost the teachers' confidence, it does not directly help them to form a view of mathematics which increases their effectiveness as teachers. Rather, the mathematical knowledge which it is helpful for primary teachers to have is specialist in nature. Indeed, it can be argued that there is not a "unique essence of some unitary culture called 'mathematics'" at all, but that mathematics itself is defined and changed by the context within which it is put to use (Evans & Tsatsarone, 2000).

So, of what might this specialist, context- related mathematical knowledge for teachers consist? It has been suggested, by Davis & Simmt (2006) that, "for teachers, knowledge of established mathematics is inseparable from knowledge of how mathematics is established". They suggested four areas of mathematical knowledge that are important for teachers: mathematical objects (involving developing a rich picture of mathematical topics, with links, analogies and figurative aspects); curriculum structures (involving analysis of the different mathematical techniques which can be brought to bear on curriculum topics); collective dynamics (looking at how the knowledge possessed by individuals in a class can become shared by the 'classroom collective'); and subjective understanding (i.e. the nested levels of understanding, involving social and cultural knowledge, which an individual develops over time). These four areas do not separate 'mathematics' from 'learning mathematics', and this view equips teachers to be confident and facilitative in their approach to pupils. Graeber (1999) offers a similar analysis of the forms of mathematical knowledge which teachers should have. Her five suggested 'big ideas' are compatible with those of Davis and Simmt, and cover a similar range, with an emphasis on understanding how students learn, and on the importance of exploiting the rich variety of possible ways to understand a topic. It seems, therefore, that a specialist understanding of mathematics is one essential component of teacher development, and we might expect to find this in our exploration of the impact of MR training on staff constructs.

2.3.2. Constructivist Approaches

The Mathematics Recovery principles are rooted in a constructivist approach, where mathematical knowledge is seen not as existing 'out there', as an objective and discoverable entity, but as something which each individual constructs for himself, through a flexible and cumulative process of assimilating experiences. In this approach, "learning is a change in construing", and "learning always involves simultaneous changes in perceiving, thinking and feeling" (Thomson & Harrri-Augstein, 1985). This view is in tune with recent developments in the fields of cognitive psychology and of educational theory, where constructivist views are very much to the fore, to the extent that they could be regarded as the new orthodoxy. As Phillips puts it, the literature on constructivism is "enormous, and growing rapidly", and "constructivism has become something akin to a secular religion" (Phillips, 1995).

This is not the place for a detailed discussion of the wide variety of constructivist positions which have been documented, or for a full rehearsal of the hotly contested epistemological debate around the issues which arise from them. (For more detail see, for example, Bereiter, 1994; Mahoney, 1988; Von Glasersfeld, 1994 & 1995.) However, it will be helpful to outline the broad stance which is taken by educationalists under the constructivist umbrella, and to highlight the issues raised which have implications for the current study.

Constructivism insists on the active role of the individual, in shaping how reality is understood. Internal representations of the self or the world are known as constructs, and are formed through the processing of experiences, which can be perceptual, emotional, sensory or verbal. Constructs are revisable, formed in a social context, and serve the function of optimising the person's adaptation to their experiential world (Kelly, 1955 & 1991; Shotter, 2007; Toomey & Ecker, 2007). Within this framework, although the objective reality of the external world can be admitted (Kivinen & Ristela, 2003), our knowledge about the world is not absolute or true, but is constantly under reconstruction, and "must always be regarded as only a currently adequate, currently useful result of socially-shared construction processes" (Terhart, 2003).

There are several current theoretical orientations of constructivism, which put emphasis on different aspects and mechanisms of the above framework. Terhart distinguishes between four broad theoretical orientations: radical constructivism, the neurobiology of cognition, systems theories and conceptions of learning within cognitive psychology (Terhart, 2003). Radical constructivism focuses strongly on the process by which individuals use experiences to test and restructure their construct systems, and on the mechanisms by which co-constructions form between people in social contexts. The Neurobiological approach focuses on the physiological level of explanation, looking at how neural networks are formed and restructured within the brain, in response to experience. The Systems Theory approach takes the neurobiological concepts, and uses them as a metaphor for how systems develop at higher levels: individuals, groups, societies, political systems and "a whole world" (Terhart, op cit). The Cognitive Psychological approach seeks to integrate information-processing models of learning (which focus on internal structures) with behaviourist models (which focus on external stimuli and responses), looking at the process by which internal structures are modified by external events, and what consequences this will have for future actions and thoughts. Different writers do not agree about where the varieties of constructivism fit, and there are arguments about whether it amounts to a theory, a whole new paradigm, or merely a description (Terhart, op cit; Fox, 2001; Kivinen & Ristela, 2003; Toomey & Ecker, 2007). What all constructivist theories seem to have in common is "a metaphor for learning, likening the acquisition of knowledge to a process of building or construction" (Fox, 2001, p23), with a view that knowledge is actively constructed by learners, in a dynamic way.

2.3.3. Acquiring Mathematical Knowledge through Constructivist Approaches

Notwithstanding the unresolved philosophical and theoretical issues around constructivism, it has proved very influential in the field of education. As Terhart (2003) points out, it was first implemented in mathematics and science teaching, as these two subjects have always had relatively close links to the psychology of learning. The constructivist orientation is now quite well established amongst mathematics educators, and it is associated with a continuing shift away from a 'transmission' view of teaching, towards a 'teacher as facilitator of independent learning' view. As Ernst (1994) points out, transmission-based educationalists see teaching as concerned with transmitting an established body of knowledge to the learner, whereas constructivist educationalists see teaching as supporting learners through a dynamic process of restructuring their understanding. Thinking amongst mathematics educators has shifted. A pre-1960 view of mathematics education saw it as being the transmission of a fixed body of knowledge. As Arzarello, Robutti & Bazzini (2005) put it, this "transmissive" model, "disconnected from a rich experiential base, can create obstacles to learning". The post-Piagetian view to which maths educators have shifted, on the other hand, sees the pupil as constructing personal knowledge through interaction with the world. A key concept in this shift has been that of 'understanding': once seen as consisting of the ability to apply procedures to obtain correct answers to problems (i.e. 'instrumental understanding', as described by Skemp, 1976), this is now seen as consisting of the construction by the learner of an internal model of the subject area, from which solution procedures for particular problems can flow ('relational understanding', Skemp, op cit).

Despite the dominance of constructivist approaches in mathematics education today, there are still unresolved tensions and areas of controversy. Maths educators, because of the need to support teachers in functioning within a social environment, have tended to focus on socio-cultural perspectives, rather than on radical constructivist ones (Confrey & Kazak, 2006; Steffe & Kieren, 1994). Social constructivist positions might seem to offer the most direct relevance to instructional practice, as they acknowledge the context of the learning and the resources needed for it, including issues of classroom constraints, language and cultural background (Bjorkqvist, 1998; Cobb, 1996; Irvin, 2008; Telese, 1999; Towse & Saxton, 1998; Ueno, 1998). However, as Confrey & Kazak (2006) explain, although radical constructivism chooses individual experience as its main 'unit of analysis', this does not mean that it is unable to take other perspectives into account. Learning is always a matter of individuals restructuring their constructs according to environmental and social experiences. The job of the teacher, then, is to "promote constructivist learning" (Confrey & Kazak, op cit, p329) through arranging the social and environmental contexts for the learners.

Another criticism of the radical constructivist approach, with its insistence that each individual constructs their own understanding through an active process of successively reorganising their experiential world (Von Glasersfeld, 1995), has been that it denies the objective existence of mathematical knowledge. However, it is important to distinguish between the world itself and our knowledge of it: radical constructivism gives an account of how we come to know the world, but leaves open the questions about the nature of the world itself. Von Glasersfeld points out that, rather than being a pale copy of the world itself, our knowledge of the world is a tool constructed to fit our individual experiences and to work in our particular context. He likens it to a key, which is only one of many different keys which could potentially fit a particular lock (Von Glasersfeld, 1982, cited in Confrey & Kazak, 2006).

We have seen that there has been a shift in the thinking of maths educators, over the past thirty or more years, towards constructivist approaches (Confrey & Kazak, 2006; Steffe & Kieren, 1994). There are consequences to this shift in thinking, for the practice of mathematics teaching. Many of the practical ideas about teaching which are espoused by constructivist thinkers, such as practical learning, self-directed learning and co-operative group learning, are not new and were already well known to 'progressive' educators. However, the constructivist literature does provide useful new language with which to debate issues in teaching and learning, and a broad framework within which the ideas can be used together. The Dutch Realistic Mathematics Education (RME) movement is a powerful example of the implementation of such a framework: classroom situations (such as the 'country bus' described by Aubrey, 2000) which have the capacity to be easily used as mathematical models for elements of the curriculum are set up by the teacher. The pupils are given opportunities to work practically with these situations, to collaborate with peers in discussing them, and to reflect on challenging questions which the teacher poses about them. (For example, see Treffers, 1993; Freudenthal, 1991.) Importantly, the role of the teacher in constructivist teaching models such as that of RME has shifted, "from directing to guiding" (Milo, Ruijssenaars & Seegers, 2005): the teacher is no longer a transmitter of a body of knowledge, but a facilitator of students' own construction of knowledge. How these constructivist principles might be operationalised in practice in the classroom will be considered below, through commenting on their application in Mathematics Recovery teaching. (See 2.3.4 below.)

Perhaps the most direct application of constructivist ideas to teaching can be seen in the problem-based learning (PBL) approach. In its purest form, PBL presents a group of learners with a real-life problem, and asks them both to solve the problem, and to reflect upon the solution process. The teacher has a role in supporting the process, through probing the learners' responses, and in guiding and facilitating their access to a variety of available resources (Hmelo-Silver, 2004; Kumar & Natarajan, 2007). PBL has been widely used in medical education, to develop clinical diagnostic skills amongst medical students (Camp, 1996). Its use in education of school-aged pupils is less well-developed, and implementations tend to be in the style of PBL, rather than the pure form. The reason for this, as Hmelo-Silver (2004) suggests, may be that teachers feel that the self-directed learning aspect of PBL is difficult for young children, who need more scaffolding by the teacher, to support their reflection, and may even need some direct instruction, at points in the problem-solving process where the child perceives the need to acquire a particular skill. This is an issue for PBL: to what extent are its benefits, in terms of learner independence, motivation and ability to adapt and generalise, lost if an element of more direct instruction in included? As will be seen below, the Mathematics Recovery teaching approach is closely related to PBL, and its principles minimise the use of direct instruction, and limit the use of modelling or demonstrating to circumstances where they are used to aid the learner's review of or reflection on their own thinking.

2.3.4. Mathematics Recovery as a Constructivist approach

Mathematics Recovery teaching can be seen as one, highly structured implementation of problem-based learning. The one-to-one teaching sessions begin by presenting a problem to the pupil. The teacher allows plenty of thinking time for the pupil, without interrupting them, and observes the pupil's responses carefully. If the pupil responds incorrectly, the teacher will choose one of a number of ways to support them to succeed on the task: re-presenting the same task, presenting a smaller/easier version of the task (known as 'micro-adjusting'); changing the setting for the task by re-presenting it with different equipment or context; scaffolding the task by providing prompts. The teacher chooses the lightest, least intrusive method of support which will be likely to succeed, and 'fades' this support as soon as the child experiences success. Wood (1998, p100) calls this approach to tutoring "contingent instruction", and comments that research with young children shows that it is more effective than are more direct or intrusive tutoring methods. It allows the child actively to construct solutions, following their own route rather than being shown a path by the teacher.

When the pupil succeeds at a version of the task, with or without the need for teacher support, the teacher uses observation and questioning to find out what strategies they used. The pupil checks their answer, so as to receive feedback. The teacher then selects and presents a new task, which is chosen so as to be slightly more challenging, with a view either to consolidating the strategy just used, or to extending it or developing a new strategy. This process, which is described fully in Wright et al (2006b), is summarised in figure 2.1 below.

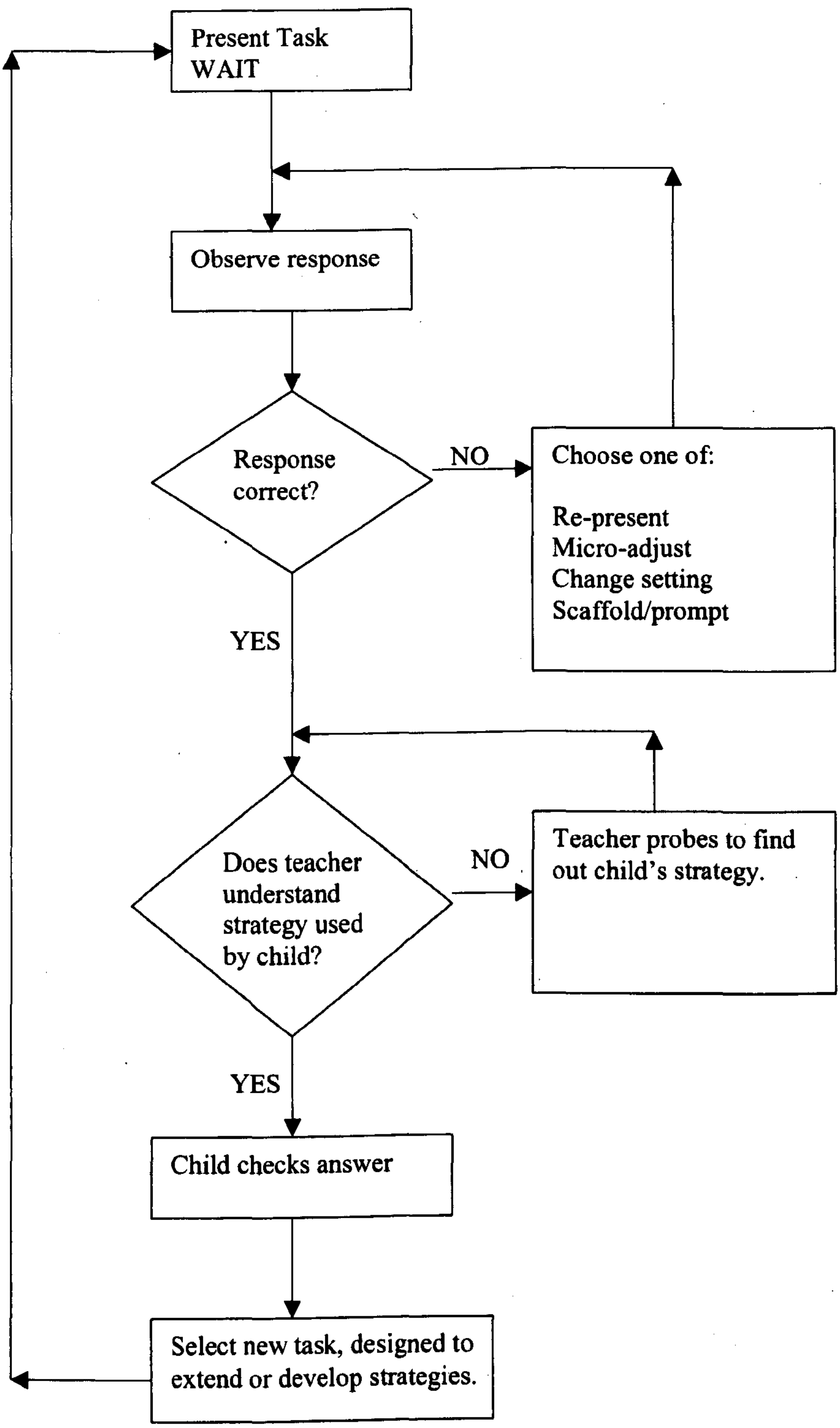


Figure 2.1: Diagram to illustrate problem-solving within an MR teaching session.

The manner in which this teaching process is carried out is guided by nine teaching principles (Wright et al, op cit), which are constructivist in their intention, as discussed in 2.3.3 above. The nine principles draw heavily on radical constructivist thinking, via the work of Steffe (eg Steffe, Ambrosio & Beatriz, 1995; Steffe & Cobb, 1988; Steffe & Kieren, 1994; Steffe, Von Glasersfeld, Richards & Cobb, 1983). They emphasize the child's learning, with the teacher taking a facilitative role. This involves observing and interpreting the child's behaviour, and trying to understand the child's current models of number. Teacher behaviour is important, but only in so far as it allows the child to have the next experience which he or she needs, in order further to elaborate their internal models – hence the importance of 'wait time', expressed in Principle 8. There is not, within the nine MR principles, any direct guidance to teachers on how they should sequence or present materials to pupils (as would be the case with direct instructional approaches). Nor is there guidance on how they should encourage pupils to co-construct their understanding through discussion with other people (as would be the case with social constructivist approaches). Rather, the focus is on providing the child with the right conditions and information for them, individually, to restructure their thinking.

The nine principles will be listed below, with further commentary to show how they are related to constructivist thinking, and how they are implemented within MR:

> ***Principle 1****: the teaching approach is inquiry based, that is problem based. Children routinely are engaged in thinking hard to*

solve numerical problems which for them are quite challenging. (Wright et al, 2006b, op cit, p27.)

This principle is exemplified in the pattern of presentation of tasks within a teaching session, shown in Figure 2.1. What is critically important here is that, because the learner is actively engaged in new thinking, they will be forming new links between areas of their knowledge, resulting in a more richly-connected and flexible internal representation of the world. This will happen at both the neural level (with the formation of an elaborated neural network) and the psychological one (with the learner being able to articulate and use new knowledge) (Toomey & Ecker, 2007). This is in sharp contrast to the traditional, transmission style of teaching, that is represented by 'showing and telling' or "explaining, that is often satisfying for a teacher while inadvertently constraining students' thinking – acting as a kind of closure to discussion" (Anghileri, 2006).

***Principle 2**: Teaching is informed by an initial, comprehensive assessment and ongoing assessment through teaching. The latter refers to the teacher's informal understanding of the child's current knowledge and problem-solving strategies, and continual revision of this understanding. (Wright et al, 2006b, op cit, p28.)*

This refers to the use of formative assessment, also known as assessment for learning, in MR, which is present throughout all assessment and teaching sessions. If, as constructivists claim, knowledge is "personal and idiosyncratic" (Fox, 2001), then the MR teacher will indeed need continuously to monitor the learner's knowledge, through ongoing assessment. In MR teaching, this is achieved through close observation of what the learner does (including gestures, actions with artefacts, moving of the lips and the length of pauses for thought), as well as asking open questions to probe what the learner has done. This use of formative assessment is "embedded in a relational view of learning" (Miller & Lavin, 2007).

Hargreaves (2005) draws out six different definitions of formative assessment, from surveying teachers' views. Mathematics Recovery assessment can be seen to fulfil the functions implied in all six of these:

- Firstly, it is used to assess pupils' performance against objectives, e.g. in looking at progress between a pre-test and a post-test for an individual pupil programme.

- Secondly, it is used to inform the next steps for teaching and learning. This is a major feature of MR programmes, as each session is planned in detail from the results of the previous one, usually with the aid of video recordings.

- Thirdly, assessment is used to give teachers feedback for improvement: this is especially so in the MR training course, where teachers watch their own videos, and receive feedback from tutors and peers in seminar sessions.

- Fourthly, formative assessment can refer to teachers learning about children's' learning: again, MR has a detailed focus on how individual pupils are learning, as well as a wider focus on the usual course of children's learning.

- Fifthly, formative assessment can refer to children taking some control of their own learning and assessment. This is most clearly seen in MR when children apply newly learned skills to challenging problems or new contexts: typically the children become determined to solve the problem for themselves, and will refuse the teacher's offer of help.

- Finally, teachers refer to formative assessment as 'turning assessment into a learning event'. This refers to the situation where the assessment is an integral part of the learning process, and is being used to make the learning explicit, so that it can move on further. This is certainly what MR teaching aims to do.

Principle 3: *teaching is focussed just beyond the 'cutting edge' of the child's current knowledge. (Wright et al, 2006b, op cit, p28.)*
This principle draws on Vygotsky's concept of "zone of proximal development (ZPD)" (Cole, 1985; Wood, 1998, pp 97)). This zone refers to that which the child can do with adult support: whilst working in this zone, the child is in a position to develop new cognitive links, which will amount to new skills and knowledge. Cobb shifts the emphasis to focus even more sharply on the child's own interpretations and cognitive restructuring, by renaming the

zone as the "realm of developmental possibilities" (Cobb, 1995). This leads us to focus on how the child's interpretations and constructs evolve, during the interaction with the teacher. Thus, the role of the teacher will involve both the selecting of activities which lie in the ZPD/realm, and the arranging of experiences which support the child in exploring new strategies, and following through the consequences of their thinking. This relates strongly to the need for the child to have extended thinking time (see Principle 8, below).

Principle 4: *Teachers exercise their professional judgment in selecting from a bank of teaching procedures each of which involves particular instructional settings and tasks, and varying this selection on the basis of ongoing observations. (Wright et al, 2006b, op cit, p28.)*

When learners are engaged in problem-based learning, the process "requires the harnessing of a variety of resources and the integration of multiple perspectives" (Kumar & Natarajan, 2007). In Maths Recovery, there is a bank of suggested activities which constitute these resources, and the teacher is encouraged to adapt these and to create new ones, as needed. Mostly, these activities consist of problems which could be solved in a variety of ways. However, some of them, especially in Key Topic 1 (Number Words and Numerals) look more like opportunities for the student to find out and rehearse socially agreed information, i.e. the names and formation of the ten numerals. Hmelo-Silver (2004) discusses how this kind of direct instruction might fit into a problem-centred approach. She suggests that, "as students are grappling with a problem and confronted with the need for particular kinds of knowledge...PBL may create a 'time for telling'..... (Hmelo-Silver, op cit, page 260). This author finds that this can be an issue for teachers who are new to Maths Recovery teaching, who may slip into 'transmission teaching', rather than helping students to build links between new knowledge and their existing constructs.

Principle 5: *The teacher understands children's numerical strategies and deliberately engenders the development of more sophisticated strategies. (Wright et al, 2006b, op cit, p29.)*
The meaning of 'sophisticated' is not well defined here. However, it refers to the child's progression through the Stages of arithmetical knowledge which are defined within MR. More 'sophisticated' strategies are those which are associated with the more advanced Stages of Early Arithmetical Learning. The MR teacher is required to analyse children's responses so that they know what Stage they are at and what strategies they are using, and then look for opportunities to present them with tasks which will challenge them to develop more sophisticated ones.

Principle 6: *Teaching involves intensive, ongoing observation by the teacher and continual micro-adjusting or fine-tuning on the* *basis of his or her observation. (Wright et al, 2006b, op cit, p29)*

This fine-tuning relates to the teacher's selection of the numbers used in successive problems, the way the equipment is used to cue the child or to help him to structure the problem, and the nature of any prompting which the teacher chooses to give. The purpose of the fine-tuning is to maximise the time in which the child is working in their ZPD, where new learning can occur. The teacher is trying to set up what Hyun and Marshall refer to as "teachable moments" (Hyun & Marshall, 2003), where the conditions are right for the child to make a cognitive leap, and to be aware of having done so. This concept of a 'teachable moment' appears frequently in the literature about the teaching of young children (e.g. Ayers, 1989; Sipe, 2000), although it is rather ill-defined. In Maths Recovery, it is seen as an important moment for the learner, in terms of building confidence and motivation, as well as acquiring new knowledge structures. Jim Martland refers to it as a 'breakthrough moment' or an 'Ahaa! Moment', and encourages teachers in MR training to create and notice these moments. (Martland 2003, personal communication).

***Principle** 7: Teaching supports and builds on the child's intuitive, verbally based strategies and these are used as a basis for the development of written forms of arithmetic which accord with the child's verbally based strategies.* (Wright et al, 2006b, op cit, p 29.)

The SEAL Stages in MR show that verbally-based strategies precede written forms, for most young children. The MR programme builds on the children's understanding which underlies these verbal strategies, and written numerals are initially used only to symbolise and record the results of mental computation.
This approach is strongly supported by a body of research into the development of children's computational strategies, which suggests that children should be encouraged to compute mentally using counting strategies, and then to develop informal ways of supporting this through notation, rather than being taught formal written methods for solving standard types of problems. (See Anghileri, Beishuizen & Van Putten, 2002; Willey, 2004.) This leads on to a new approach to calculating with larger numbers, with the child's appreciation of place value being based on verbal counting across tens boundaries, rather than decomposition of tens into units. This amounts to encouraging children to construct sequence-based 'jump strategies', rather than collections based 'split strategies' (Ellemor-Collins & Wright, 2007). Research shows that this approach is more successful than written algorithms, as a way for children to learn to calculate with larger numbers. (e.g. Van den Heuvel-Panhuizen, 2001; Willey, 2004.)

Principle 8: *The teacher provides the child with sufficient time to solve a given problem. Consequently, the child is frequently engaged in episodes which involve: sustained thinking, reflection* *on her or his thinking and reflecting on the results of her or his thinking. (Wright et al, 2006b, op cit, p30.)*

This principle arises from the need to teach within the child's ZPD, as the child is tackling new and challenging problems, which require hard thinking. Because the teachers undergoing MR training are able to work intensively with individual children in a one-to-one setting, it is possible to give the child as long as is needed, to think about each problem. This author has noted that teachers are often surprised by the fact that pupils are not stressed by this long 'thinking time', but do not like it if the teacher interrupts it prematurely. Hatfield discusses this point, saying that;

> "As a teacher one needs to decenter – get out of the way, step aside, and allow the learner the opportunity to engage the challenge, per se. Wait, watch listen – intervene to help focus, or to clarify, or to provoke analysis, or to reflect." (Hatfield, 2001).

The role of reflection is important in MR, and is supported explicitly, not just through allowing time for it. The teacher 'probes' the child's response, to find out what strategy the child used, so that the child will make their own strategy explicit, and reflect upon it. Doing this with the support of a teacher also helps the child to develop awareness of the range of strategies they have, and of how to evolve new ones. As Hmelo-Silver puts it,

> "Reflection helps students (a) relate their new knowledge to their prior understanding, (b) mindfully abstract knowledge, and (c) understand how their learning and problem-solving strategies might be reapplied." (Hmelo-Silver, 2007, p 247.)

Principle 9: *Children gain intrinsic satisfaction from their problem-solving, their realisation that they are making progress and from the verification methods they develop. (Wright et al, 2006b, op cit, p30.)*

Whilst pointing out that there is little empirical data about motivation towards learning in school-aged pupils, Hmelo-Silver (2004) takes the view that problem-based approaches are likely to enhance motivation, because learning issues are arising directly from the problems, in a situation where the students have a need to know. The MR teaching is organised so that there is no direct teaching of skills outside the context of particular problems. The structure of the sessions makes it clear to children that they are moving on, with brief revisiting of easier problems, in preparation for tackling harder ones. As far as possible, verification of the child's answers is built into the problem (e.g. when the child uncovers equipment and checks visually, to verify a mental calculation.)

The importance of this kind of intrinsic satisfaction is implicitly highlighted in official government guidance as part of the 'Every Child Matters' agenda, where 'Enjoy and Achieve' is one of the five main outcomes upon which all Children's Services are expected to focus (HMSO, 2003). There is, however, little official guidance offered about how this enjoyment is to be fostered, or how it links to achievement. This author, in working with MR teachers in training, has found that teachers often comment upon how pupils' enjoyment has blossomed as a consequence of doing an individual MR programme, alongside their confidence and their actual numeracy skills.

It has been shown how the nine Maths Recovery teaching principles are constructivist in their intention, and how they are worked out in the delivery of the MR programme. One aim of the present study is to explore how far teachers adopt these principles and become more constructivist in their outlook, following the experience of training and practising in Maths Recovery.

2.4. TEACHER DEVELOPMENT

Having considered the nature of mathematics learning, the discussion will now turn to the issue of how teaching staff might develop the capacity to support this learning. As described above, there has in recent years been a deep debate about the theoretical issues around the teaching and learning of mathematics. As Jaworski puts it, 'big theories' such as constructivism and sociocultural theories have become very influential amongst mathematics educators. In her view, though, these theories are seldom translated into clear insights into ways of promoting learning through teaching (Jaworski, 2006).

2.4.1. Becoming a 'Good' Teacher of Mathematics

There is a large and growing literature on Teacher Development, although the area is somewhat ill-defined (Evans, 2002). It has to do with positive changes which occur in teacher practices, attitudes and beliefs over time –

although the criteria according to which these are evaluated as being 'positive' are often not made explicit. As Wilson et al express it; "the notion of good mathematics teaching is an elusive concept that, nevertheless, has permeated the literature for decades" (Wilson, Cooney & Stinson, 2005). This looseness is a problem for the applicability of such research. Without specifying the criteria for evaluation, the conclusions of such research will slip into being mere opinion, and will not be influential. The current research will seek to make the basis for such evaluation explicit. It will explore changes which occur in teaching staff's constructs, and, through the use of an overall donated summary construct of 'teaches numeracy very well', will tap teaching staff's own understanding of good teaching, and their evaluations of their own teaching. In addition, it will attempt to use the nine MR teaching principles set out above, as a basis for evaluating the changes which staff perceive themselves to have made.

2.4.2. Approaches to studying teacher development

The body of literature on teacher development in the area of mathematics is vast. (See Kanes & Nisbet (1996) for a review, and for examples of the approaches taken see Bobis, Clarke, Clarke, Thomas, Wright & Young-Loveridge, 2005; Korthagen & Russell, 1999; Manouchehri, 2002.) The literature has a strong focus on initial training, perhaps because initial training institutions have access both to research time and to teachers in training (for example, Fives & Buehl, 2008; Hanley & Brown, 1996; I'anson, Rodrigues & Wilson, 2003; Schneider & Ammon, 1992). There is rather less work on how experienced teachers learn within the job, although it is often acknowledged that experienced teachers possess a more sophisticated view of learning (Cooney, 1999), and take a more reflective stance (Lowery, 2003). The present study makes a contribution to this area, by considering in detail how the thinking of experienced staff changes in response to undertaking and implementing Maths Recovery training.

In order to elucidate the nature of recent research on mathematics teacher development, selected studies will be used as illustrations of five facets of it which have relevance to the present study. One type of study consists of detailed case studies of the development of individual teachers, in response to inputs from courses and school experiences. For example, Tzur, Simon, Heinz and Kinzel give an account of a fifth grade teacher in the United States, which they derive from classroom observations and interviews (Tzur, Simon, Heinz & Kinzel, 2001). The teacher, Nevil, was participating in education reforms which intended him to become more constructivist in his outlook. However, he developed in a way which did enable most of his pupils to perform well on tests of their mathematical knowledge, but did not focus on what sense the students were making of the mathematical situations. Instead of observing and analysing student responses, Nevil analysed his own knowledge of the mathematics into small steps, and presented students with experiences which he thought would help them to construct each step. Although many of the activities and experiences which he presented to the students had good potential to be used in a problem-based manner, he was always seeking a predetermined, 'correct' response from the students, and thus he was only able to support them down his own path of thinking. Tzur et al reflect on how Nevil's teaching was being shaped both by fundamental assumptions about the nature of mathematics, and by features of the environment where he taught. Nevil's explanations of why he took particular approaches in his teaching were able to reveal the model of teaching and learning which he was using, in a very powerful way. Similarly, Sherin (2002) gives an account of the development of the maths teaching of one middle school teacher, across a year, based on observations, videotapes of lessons and discussions with the teacher. This teacher, across the year, evolved a method of handling the tension between using a student-centred process of mathematical discourse, and ensuring coverage of particular mathematical content. He first elicited student ideas, and encouraged elaboration and exploration of these. Then he filtered the ideas, focusing the students on those relating to the target mathematical content. Finally, he encouraged student-centred discourse about these ideas. This process is noticeably similar to that employed by MR staff in a teaching session: having presented a problem to the child, the MR teacher stands back and allows the child to bring their own ideas to it. The teacher then offers any necessary support, but this cues from the child's approach, rather than from the way the teacher would have done that problem. Later, the teacher presents problems which are selected so as to lead the child to focus on new strategies and approaches, in order to enrich the child's strategies. Finally, the teacher presents increasingly challenging problems, requiring the child to bring a variety of strategies to bear, and the teacher supports the child to make explicit their new strategies and the links between their strategies. Like the approach used by Sherin's teacher, this process involves alternate tightening and loosening of teacher direction, with the aim of facilitating student-centred learning.

Another type of study looks at how teachers in training can learn from studying reports of the experiences of others. For example, Masingila & Doerr (2002) used multimedia case studies, in supporting student teachers to develop rationales for using children's thinking to guide instruction. The student teachers used the case studies as a site for investigation, analysis and reflection. Later, Masingila & Doerr found that the students were able to refer back to the case studies, in discussions where they were formulating strategies for tackling issues which arose in their own teaching practice. This kind of use of collaborative discussion of others' practice, in the training of teachers, is also strongly present in MR training. MR courses involve trainees in making video recordings of their own teaching sessions, and presenting these to peers in tutorial groups, in the context of a problem-solving discussion. This experience, although initially daunting for the trainees, is often nominated by them as being a very helpful part of their course. Importantly, it seems that teachers can benefit from studying others' teaching, but this needs to be in a context where they are encouraged to apply the ideas in their own, current, teaching.

A third type of study approaches teacher development through analysing reflective journals which teachers are asked to keep. For example, Schneider & Ammon (1992) asked a student teacher to keep a weekly journal of his thoughts about his teaching. Their analysis of this showed that, rather than acquiring new skills in a linear, predictable way, he had sudden insights. These were associated with conflicts that arose when his previous approach was not working in the classroom, and he had to try something new. He would then write about this in his journal, making explicit his new pedagogical thinking, and linking it to the rest of his constructs about teaching. This reflective approach is espoused by MR (see Principle 8 above) and more will be said about the role of teacher reflection, below.

A fourth type of study, which is of particular relevance to MR, is one where student teachers are asked to conduct and analyse one-to-one mathematics assessment interviews with children. This is followed up with discussions between the student teachers, and then an assessment of how the student teachers' knowledge has developed. In one such study, McDonough, Clarke & Clarke (2002) found that the student teachers became more aware of the variety of strategies children used, and of the relative sophistication of the strategies, and that the discussions stimulated the teachers to reflect on how to provide appropriate experiences for learners. Again, this methodology is strongly used in MR, where teachers learn to conduct an individual assessment interview, and to analyse the results in terms of which strategies children are using, prior to planning appropriate learning experiences for the children. During MR training, the teachers are asked to show and discuss their tapes of assessment interviews, as in the McDonough et al research. Evaluations of MR training have shown that the teachers do, as expected, acquire more knowledge of children's strategies, and of their relative sophistication (Thomas & Ward, 2001).

The fifth type of study is one which is more often used with experienced teachers, and tries directly to ask the teachers about the processes by which their teaching has developed. Typically, teachers are given semi-structured interviews, which are analysed qualitatively, and examples from individual interviews are then used to illustrate general points which have emerged from the analysis. Wilson et al (2005) conducted such a study with nine experienced teachers of mathematics, who were acting as mentors to trainee teachers. They concluded that the teachers thought good teaching requires knowledge of maths, engages and motivates students, requires effective management skills and promotes mathematical understanding. Interestingly, the notion of 'understanding' the teachers used was not a strongly constructivist one. They said that they needed to know what the students' current mathematical understanding was, in order to pace their instruction (through teacher-determined, curriculum-led steps), rather than as a means of shaping the content of their instruction to respond to students' current construing of the mathematics. This is one of the issues which is examined in the current study: do teachers who have trained in and used Maths Recovery become more constructivist, in their beliefs about learning and teaching?

2.4.3. Thoughts, Beliefs and Identity

This leads us on to consideration of teachers' own constructions about teaching. There are two issues which seem to recur, in the constructivist-orientated literature on teacher development: that of teacher beliefs and identity, and that of teacher reflection. Both of these are important for the current study, and the literature about them will be briefly reviewed.

In recent literature, teacher beliefs are often viewed as being 'sensible systems' (Leatham, 2006), and this is contrasted with traditional, positivist views which have suggested they can be inconsistent (internally, and with teacher actions). The positivist view would state that teachers can articulate their beliefs, and that, when they articulate these beliefs, the researcher will share their understanding of them. (See, for example, Kagan, 1992 and Pajares,1992.) This view might also expect that teacher actions would be in line with these declared beliefs. However, Leatham's view of beliefs is a constructivist one, in line with many other writers (Kelly, 1955/1991; Handal, 2003; Rokeach, 1968). It describes beliefs as being in a complex, interdependent system, which is constantly being revised to reflect new information. Changes to one part of this system will affect other parts, needing continuous reorganisation of the system: beliefs which are 'core beliefs' are those which are very intimately linked to many others, so have particularly massive effects on the whole system, when they change – and people are likely to find such massive system changes stressful or difficult. Because the system is constantly changing and evolving in response to experience, one would not expect actions to be consistent with beliefs, at any one time: rather, one would expect actions always to be changing so as to achieve greater compatibility with the ever-changing belief systems. This approach to beliefs is clearly formulated in the 'Constructive Alternativism' of George Kelly (1955/1991), which will be further discussed below.

Research with serving teachers suggests that it is difficult to effect change in teacher beliefs, towards constructivism. Warfield, Wood & Lehman (2005) worked with seven elementary teachers, to influence them towards reform recommendations (which were constructivist in nature). They found that, although all the teachers adopted some of the suggested new procedures, only three of them adopted more complex practices in which children participated in collaborative inquiry. Beswick (2007) investigated the orientation of twenty-five secondary school maths teachers, and found that only two of them had developed a constructivist orientation, despite the existence of official reform guidance.

The reasons for the apparent difficulty in changing teacher beliefs are complex. One factor involves the external constraints which teachers perceive to be on them. In England and Wales, even though current government advice documents are consistent with constructivist approaches, there is regular testing of children's skills which is used to assess schools' effectiveness (Department for Children, Schools & Families, 2007). This makes it risky for teachers to commit to a change in style which may take some time to become effective: they may feel unable to take the chance of a short-term dip in measured pupil performance, even if they believe that the longer term benefits to pupil understanding and performance would be large. The new Scottish 'Curriculum for Excellence', by contrast, emphasises pupil entitlement to be supported to develop their skills, rather than focusing so strongly on the measuring of performance. It stresses the professional autonomy of teachers, giving them freedom to adapt the curriculum to local circumstances, and telling them to aim for learners having "opportunities to use higher order learning activities and develop breadth of learning.......rather than rapid movement through (curriculum) levels" (Scottish Government, 2008). As yet, it is too early to see whether the greater freedom given to Scottish teachers will have an effect upon their ability to develop their beliefs about teaching and learning and implement these in their professional development.

In addition to the constraints of government guidance, external factors operating on teachers include parental expectations, administrative demands, school policies, the nature of textbooks and style of supervision. All of these can militate against making major changes in one's teaching. As Handal put it,

> "Teachers' beliefs do influence their instructional practice; however, a precise one-to-one causal relationship cannot be asserted because of the interference of contingencies that are embedded in the school and classroom culture.............Teachers' mathematical beliefs are seen as self-perpetuating within the atmosphere of a system that promotes progressive teaching but in fact helps in maintaining traditional beliefs and practices."(Handal, 2003, p54.)

Taking the perspective suggested by Handal leads one to reflect on how teachers might be supported to develop in more constructivist ways. Peter Kelly (2006) discusses this, pointing out that, just as children need support towards constructivist learning, teachers also need such support. They are in the process of constantly restructuring their professional knowledge, through direct experience of teaching, practitioner research, training and collaborative problem solving with colleagues. This is an inherently social process, with a 'situated expertise' developing as they participate in the discourse of effective teaching. In becoming expert in this way, people build their identities as teachers, and continuously elaborate these in response to ongoing experiences (Lave & Wenger, 1991; Wenger, 1998). In order to do this, teachers need both to participate, and to reflect. Handal suggests three implications for the design of teacher learning: firstly, there is a need to foster collaborative and reflective partnerships between schools and higher educational institutions; secondly, to explore 'knowing-in-practice' methods such as providing opportunities for teachers and students to learn alongside each other; and thirdly, to seek forms of in-service training which encourage the formation of reflective, discursive, elaborative teacher identities. There is a reflexivity here: if we wish teachers to teach pupils in a constructivist way, then their own mathematical experiences "need to be congruous with the kind of teaching we would expect of a reflective, adaptive teacher" (Cooney, 1999).

Reflection, then, is seen in the literature as being a very important aspect of the development of teacher development. However, the literature seems not to dwell much on the mechanism by which reflection might operate, or on its possible differential importance for teachers who hold different philosophies. Artz, Armour-Thomas and Curcio (2008) do explore in detail the process and tools involved in reflective practice, though not so much the nature of the learning involved. They propose a model for the reflective teacher: there are two frameworks, an 'instructional practice' framework (concerned with tasks, learning environments and discourse) and a 'teachers' cognitions framework' (concerned with goals, knowledge and beliefs). They describe how teachers use these frameworks together in the three phases of planning the lesson, interacting with pupils during it and evaluating (and revising) their approach afterwards. It seems to this author that this reflective process is particularly critical for constructivist teachers. Such teachers seek to facilitate pupils in restructuring their understandings in response to experience. They also need continuously to be going through this same process themselves, and ongoing reflection is central to this. Direct modelling of 'how to teach' will be of very limited use here: rather, the teacher needs to observe and reflect upon the effects of a varied range of ways of teaching, and have opportunities to experiment in their own teaching, without feeling pressured by assessment of their performance. There is an analogy here with how a therapist might support a client, when using 'Fixed Role Therapy' within the Personal Construct Psychology model (Kelly, 1955). The therapist would help the client to describe themselves, and to describe some possible alternative (not necessarily better) ways of being. The therapist would then support the client to try out a different way of acting, and reflect on its consequences. At no point would the therapist advise the client what to do, as that might result in them changing their circumstances, "without in any way changing their outlook" (Kelly, op cit, Vol 2 p289). Instead, the client adapts and adjusts their construct system to take account of the new information about how they can interact with the world, and this affects their future planning about what to do. In a similar way, the constructivist teacher is able to develop their philosophy and practice of teaching through experience, in so far as they reflect upon that experience and allow it to influence their approach. This is in sharp contrast to more transmission-based models of teacher development, which focus on the teacher acquiring a set of externally pre-defined skills, usually with pressure from ongoing performance assessment.

There is, however, considerable agreement that not enough reflection takes place in teacher education, especially in initial training. Spilkova (2001) describes how the concept of a 'reflective practitioner' is new in teacher education in the Czech Republic, and how teacher education still emphasizes the learning of specific skills and algorithms. The same appears to be true in the USA, as exemplified when Lowery says,

> "Even though the role of reflection in teaching is considered important, reflective action in preservice and inservice teachers is either inhibited by isolation of teachers or by structure of courses and schools" (Lowery, 2003, p 24).

In the UK, Tickle presents the view that new teachers are generally seeking technical or clinical competence, and lacking the opportunity and the awareness to reflect on their own educational aims and values. He says that we need to take aspects of self-identity more seriously in teacher education, including a range of personal qualities such as empathy, sensitivity, tolerance of differences (Tickle, 1999). In fact, his list of qualities is very similar to those which Goleman (1996) describes as comprising Emotional Intelligence, and says are a critically important focus for all education. Tickle advocates the use of self-appraisal, as a way for teachers to use reflection to develop their identity as a teacher (Tickle, 1999). By this he does not mean the formally recorded, externally accountable appraisal process which is built into teachers' conditions of service, with its agreed targets. Instead, he is referring to a more humanistic self-appraisal, a deeper ongoing process, leading to the development of teachers who are confident in their own ability to change and grow.

Not only is there agreement in the literature about the need for reflection, there is also a recurring theme about the usefulness of joint reflection. This refers to the process where a teacher reflects on experience, and discusses this, with peers and with teacher educators or researchers. For example, Ticha and Hospesova (2006) describe work they did with elementary school teachers, who carried out some instructional experiments, then reflected on the process, in a group with the researchers. This resulted in considerable shifts in the constructs the teachers held: they became more interested in theory, less certain of their methods and more experimental, more valuing of discussion with others, and more committed to reflection as a tool for self-development. Scherer and Steinbring (2006) carried out broadly similar work with elementary school teachers, and concluded that joint reflection between teachers and researchers, using the teachers' own classroom interactions as concrete examples, leads to changes in teacher constructs, and to long-term changes in teacher behaviour. They concluded that opportunities for such reflection need to be built into the experiences of teachers, but also that more research is needed into the features of teacher/child interactions which tend to lead to child-centred, as opposed to teacher-centred, teaching.

Reflection, in order to be effective, has to be systematic. Perhaps this is the reason why joint work between researchers and teachers is so strongly advocated, as the researcher can act as a facilitator and guide, with experience of the kinds of structures and activities which are likely to be productive of teacher change. The literature abounds with suggestions for such reflective activities, some of which are discussed below. What these suggestions seem to have in common is that they provide the teacher with something with which they can compare their own practice, in order to make explicit, in shared language, the beliefs, theories and practices under which they are operating. They are then in a position to review these, and possibly decide to experiment with alternatives. The data with which the teachers compare their own practice can consist of:

- The views of other teachers, as in the work of Sherer & Steinbring (2006) and that of Ticha & Hospesova (2006).
- A written statement, which can be the teacher's own writing. For example, a reflective diary, or a written essay set and supported by a researcher or trainer (Spilkova, 2001).

- Questions or tasks which the teachers are asked to address, which involve the teachers in making explicit both their values and beliefs, and how these are being expressed in their teaching. Cooney (1999) gives examples of such 'reflective problems'. Munn, (2006) describes several reflective activities for use in Maths Recovery training.
- An external model or set of criteria, which can be used for comparison with teachers' own practice. Artzt and Armour-Thomas (1999) develop a detailed 'framework for examining mathematics instruction', and suggest that it might be used in this way. Their framework is derived from content analysis of observational and interview data on the practice of fourteen teachers. This framework is not being held out as representing good practice: it is descriptive of some current practice, and intended to stimulate debate.

  Another example of the use of an external set of criteria to promote reflection is in the use of the nine teaching principles of Maths recovery, discussed above (Wright et al, 2006b). Here, the principles are being advocated as representative of good MR teaching, and staff in training are asked to view video recordings of their own teaching, and to reflect on whether it exemplifies the principles.

Current research sees reflective practice as essential for the development of constructivist approaches to teaching. In the implementation of Maths

Recovery training used by this author, staff are encouraged to engage in ongoing reflection, in a number of ways: they are asked to keep a reflective diary (though this is private, not discussed with their tutor); they videotape their assessments and teaching sessions, and use these to plan future teaching; they show and discuss their tapes in tutorial sessions; they have tutorial sessions to discuss ongoing teaching programmes with individual children; they are encouraged to discuss and reflect upon how MR can be used in their schools. This reflection does not cease when staff complete their initial MR training: it is built into the running of MR programmes, and tutors remain available for consultation if needed. The process of how staff development is supported through reflection in MR is represented diagrammatically, in Figure 2.2 below.

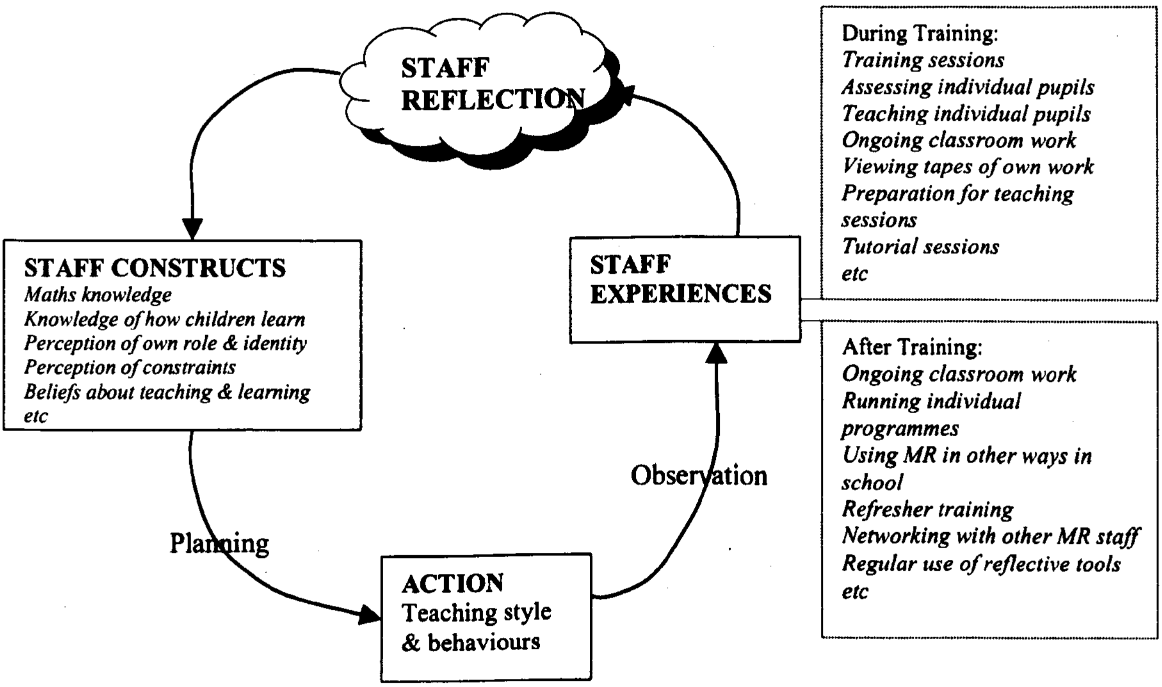


Figure 2.2: Model of staff development as teachers of mathematics, through MR training (reflective practitioner)

2.5. EXPLORING THE CONSTRUCTS OF TEACHING STAFF

2.5.1. Selecting a Method for exploring constructs

We have seen how the literature supports the view of children's learning as being a process of active construction through experience and reflection, and how this has implications for the role and the development of teaching staff. The process by which staff learn and develop is similar to that for the children, and the staff too are constantly reconstructing their beliefs and models of the world. It is this process of changes in staff beliefs and constructs about learning and teaching which is the focus of the current study. In order to study how staff constructs change in response to particular experiences, we will need a way of accessing and describing their inner worlds. This requires a theoretical framework, and an associated methodology for investigating areas defined by it.

After considering a number of alternative methodologies, including varieties of surveys, attitude measures and structured and semi-structured interview methods (Oppenheim, 1992), the framework which has been chosen for this study is that of George Kelly's Personal Construct Psychology (PCP). This is for two main reasons. Firstly, it is philosophically consistent with the constructivist view of teaching and learning outlined above (Botella, 1994; Butt, 2004; Neimeyer & Baldwin, 2003; Raskin, 2002). Raskin (2002, op cit) characterises Kelly's PCP theory as being an example of 'epistemological constructivism' (as espoused by von Glasersfeld), because Kelly believed that, whilst there is an external reality which exists independently of the observer, the observer is only able to know that reality through their own constructions of it: these constructions can never mirror reality in a one-to-one way, but can be tested against the world, and found to be more or less viable as a way of operating in the world (Raskin, 2002). Importantly, this philosophical framework allows one to consider people's inner worlds, but in relation to their decisions and actions in the external world – unlike behaviourist theories which often leave out the inner world of thoughts and emotions, or psychodynamic theories which can be difficult to connect to everyday decision making. As a framework for looking at teacher development, this ability to bridge the inner and outer world makes such an outlook very useful. Teachers, because of their need to take decisions about ongoing classroom actions, are eminently practical and pragmatic in their needs, but also require their emotions and beliefs to be taken into account. As Kelly himself wrote about PCP,

> "In simplest terms this is a disciplined psychology of the inner outlook, a psychology that is, on the one hand, an unabashed alternative to the scientistic psychologies of the outer inlook, and, on the other, a calculated step beyond the experiential psychologies of inner *inner* feelings." (Kelly, 1955/1963, p 183.)

The second reason for choosing to employ Kelly's framework is that it has well-developed and appropriate tools for exploring constructs. The tools which are commonly used in research exploring teacher attitudes and constructs include questionnaires and various types of interviews. Denscombe (1998) and Oppenheim (1992) consider the available methods, including questionnaires (selecting from nine possible types of question) and structured, semi-structured and unstructured interviews, which can be administered individually or to a group. Denscombe points out the need to select the most appropriate method for the particular study, i.e. 'horses for courses' (Denscombe, op cit, p83). For the present study, as the focus is on the development of individual teaching staff's constructs, individual interviews were felt to be the most appropriate approach. Structured or semi-structured interviews would not have been appropriate, because they would have donated too much to the interviewees, in terms of focusing their thinking on particular areas of change. What was needed was a methodology which was able to capture, in a form of words agreed between the interviewee and the researcher, the range of ideas generated by the interviewee, without the researcher's preconceived ideas influencing the dialogue too much. The aim was to find out what the interviewees thought had changed for them, rather than just to check whether some changes hypothesised by the researcher had actually taken place. Thus, the open-ended, projective methods offered by PCP were felt to be very appropriate. In particular, it was decided to use repertory grids, to elicit constructs about teaching and learning from the interviewees, and to support them to reflect on how their thinking in this domain was changing.

2.5.2. The framework of George Kelly's Personal Construct Psychology

It may be helpful, here, to offer a brief outline of the theory of Personal Construct Psychology, and the tools which are used within it. Kelly (1955/1991) presents his philosophy, which he calls Constructive Alternativism, as a formal theory, with a fundamental postulate, "a person's processes are psychologically channelised by the ways in which he anticipates events" (Kelly, 1955/1963 p 46) and eleven corollaries, which explain the mechanisms by which a person's experiences and social interactions come to shape their construct system. (See appendix A, p255 for a summary of these corollaries.)

The basic unit of Kelly's theory is that of the Personal Construct. Personal constructs resemble dimensions which a person uses, in conceptualising the objects and events (known as 'elements') in the 'psychological space' of their world (Shaw & Gaines, 1992). This is analogous to mathematically specifying a point in multidimensional space, by means of a matrix (Kelly, 1961). Contructs are bipolar, having an emergent pole (the one which the person initially articulates) and a contrasting pole (which, for that person, is as dissimilar as possible to the emergent pole). A person construes their world by observing events, and applying their existing constructs to those events: in order to achieve a consistent system which can encompass all the events in their world, constructs become modified, new constructs are added, and relationships between constructs are formed. This is a continuous, dynamic process, and the person's construct system becomes progressively elaborated, over time. Some constructs are 'core', because they are central to the person's system, and are so richly connected to other constructs that, if they were to change, the whole system would have to be restructured. Changes to such 'core' constructs can be difficult, and are usually accompanied by strong emotions. Constructs are hierarchically organised, and a person has different subsystems for different realms of thought: inconsistencies between these are present, and continuous change towards the resolution of these is ongoing (Scheer, 1996). It is possible to have some insight into another person's construct system, through communicating it, for example through language. However, we could never fully describe another person's system, because of its personal and dynamic nature.

Personal Construct Psychology has a range of tools, for eliciting people's constructs about particular topics, and for accessing the relationships between these. It must always be remembered, however, that any description of another person's construct system which a researcher offers can only be the researcher's own constructs about that person's construct system. It can never be complete, or objectively 'true'. Indeed, it is one of the strengths of PCP that it makes this situation explicit.

There are various tools for eliciting constructs, the main one being triadic elicitation (Fransella & Bannister, 1977). In this, a number of 'elements', i.e. events or role titles from the person's experience, are chosen. The person is asked to focus on three of these elements, and to describe how two of them resemble each other, and are different from the third one. This description, when put into a form of words which is meaningful to the interviewer as well as to the person whose constructs are being elicited, represents a personal construct. If the construct, as generated, is too general, too specific, or unclear, then tools such as laddering or pyramiding are used, to clarify it or move its level. For many uses of PCP, an informal exploration of the constructs thus generated is very rich, and sufficient for the intended purposes of the investigation.

A more formal process of exploring and documenting constructs, known as a Repertory Grid (Fransella & Bannister, 1977), can be used to explore the relationship between a person's constructs, and to formulate hypotheses about the structure of the person's world. A list of some elements in the person's world is made, and each one is rated, according to each of their elicited constructs. The relationships between constructs emerge from an analysis of the correlations in the grid: this can be done by computer, or by hand. Either way, the result is a pattern of clustered constructs, and hypotheses about why they cluster in this way can be fed back to the person, and further discussed. This procedure was originally used therapeutically, to help the person to make explicit their own thinking, and therefore open possibilities for useful restructuring. It can also be used, as in the present study, to help develop and spread specialist knowledge between people, by making this knowledge explicit, and expressing it in shared language.

2.5.3. Applications of Personal Construct Psychology

The methods of Personal Construct Psychology are well-tried as tools for researching professional expertise, in a number of domains. Shaw & Gains (2003) describe how PCP grids can be used to capture people's knowledge and thus describe 'expert systems'. Examples of how such grids have been used to research expert knowledge in particular settings include work on medical GP's consultation skills with patients (Bower & Tylee, 1997); clarifying corporate values in industry (Brophy, 2003); and a vast range of investigations into management skills and into the caring professions (summarised in chapter 8 of Fransella, Bell & Bannister, 2004).

There have been a number of studies which have used PCP grids to explore teachers' constructs. Roberts (1999) describes an unpublished study by Sendan, in which PCP grids were used with Turkish student teachers of English, to track changes in the structure and content of the students' theories about teaching. This included a comparison of the students' constructions of their 'current self' and 'ideal self'. Roberts concludes that PCP is a useful framework for exploring teacher constructs, and emphasizes the need to use it in a deep way, as part of a teacher development package, and not to try to 'cherry pick' a few appealing tools from it. Participants in PCP studies often choose to engage with and share facets of their core constructs, and the researcher has an ethical obligation to respect and support this process, rather than cutting it off abruptly, once the researcher's original question seems to have been addressed. The current study will take this into account, in its design.

Baumfield & Butterworth (2005) worked with twenty teachers in one school, eliciting their constructs about teaching and learning activities, in order to help the school to explore its teaching approaches. The resulting constructs were used to create a questionnaire, which individual teachers used to rate their own beliefs with respect to each construct. As well as giving confidential feedback to each teacher, the researchers were able to identify clusters of beliefs, and associate these with particular subject departments in the school, leading to implications for future professional development and support activities. Higgins and Moseley (2001) employed similar procedures to explore teachers' thinking about information technology: they produced a standard self-rating scale using seventy constructs. In both of these studies, the teachers' constructs were elicited by asking them to compare elements, donated by the researchers, which consisted of pupils' observable classroom activities. The current study uses a similar methodology to that of Baumfield & Butterworth and Higgins & Moseley, but with a particular aim to explore the development of individual teaching staff over time: to this end, full PCP grids are carried out with each teacher, rather than just the construct elicitation phase, and an opportunity for detailed discussion of the grid results is created. The elements which are used to elicit the teachers' constructs are also different, and are chosen so as to allow the teachers to focus on how their own thinking has changed, over time.

2.6 SUMMARY

This chapter has described the Mathematics Recovery approach and the underlying research. It has set Mathematics Recovery in the context of the nature of mathematical knowledge, and has considered what kind of mathematical knowledge is required, in order to become an effective teacher of mathematics to children.

Recent developments in the teaching of mathematics to children have been outlined, showing how there has been a shift towards a constructivist outlook, and towards child-centred and problem-based approaches. The implementation of this within Mathematics Recovery has been discussed, with reference to the nine principles of Mathematics Recovery Teaching.

The implications for teacher development of adopting a constructivist stance have been considered. These include an increased focus on teachers' thoughts, beliefs and identities, and an acknowledgment of the importance of reflective practice, both for teachers in training and for experienced staff. Personal Construct Psychology has been explored, as a possible framework for use in supporting teacher reflection, in addition to its use as a tool for researching teacher development.

The focus of the current study is on exploring the impact of Mathematics Recovery training on teaching staff's constructs about the teaching and learning of number. The study involves interviewing some teaching staff who have recently trained in Mathematics Recovery, using repertory grids to explore their constructs about the teaching of number. The interviews, through the choice of grid elements, prompt staff to reflect on how their constructs about teaching have changed. Results are analysed at an individual level, and fed back to staff in order to aid their reflective practice. Results are also analysed across the interviews, in order to pull out the staff's constructs about good numeracy teaching, and to see how these relate to the MR teaching principles.

The next chapter will set out the aims of the research in more detail, and will specify the research questions which the study attempts to address. It will also outline the research methodology which will be used.

CHAPTER 3
RATIONALE AND METHODOLOGY FOR THE STUDY

Having described the broad area of investigation for the current study, and considered some of the extensive, existing literature which bears on the topic, it is now appropriate to define the aims and scope of the study more precisely. The main focus of the current study was on staff change, rather than on the effects of the MR programme on the children who received instruction from the staff: those important, positive changes for children have been documented elsewhere, both for the MR programme internationally (Wright et al, 1998; Wright et al, 2003) and for the Cumbrian programme (Willey et al, 2007; Holliday, 2007).

The broad aims of the research study will be described below, followed by the rationale for the choice of methodology. This methodology will then be outlined, leading to the specifying of seven detailed research questions. These seven questions will be used, in later chapters, to address the aims of the research.

3.1. AIMS OF THE RESEARCH

The current research study had the following aims:

Aim 1: To explore teaching staff's constructs about the teaching and learning of number.

Aim 2: To find out how teaching staff perceive their constructs to have changed, after they have completed a programme of Maths Recovery training.

Aim 3: To evaluate the extent to which the principles of Maths Recovery are reflected in the construct systems of the trained staff.

Aim 4: To evaluate the extent to which construct changes perceived by staff are associated with changes in their teaching practices, and hence possible changes for children.

Aim 5: To produce a tool (questionnaire) which staff in MR training can use to aid and review the development of their thinking about the teaching of number.

3.2. RATIONALE

As discussed above in the Literature Review (section 2.5.1 p62), there was a need to employ a methodology which is open and which avoids donating content areas, in order to avoid pre-empting the outcomes. The framework of Personal Construct Psychology was chosen for that reason, as it was possible, through careful choice of elements, to allow the interviewees to define the content areas, within the broad topic area of 'The Teaching of Number'. Thus, the study was able to explore in an open-ended way the cognitive changes which the teaching staff felt they had made, rather than just to check out whether some pre-defined objectives of the course tutors had been met.

The study was conducted in two phases, the first exploring teaching staff's views, and the second designing and piloting the tool to aid reflection. There was a distinctive method for each phase, but a consistent, underlying rationale and methodology, drawn from Personal Construct Psychology

(Kelly, 1955/1963). This rationale assumes that the views of each staff member constitute a linked set of constructs. These constructs are accessible through discussion at interview, and, if sufficient care is taken to check with the interviewees, the constructs can be expressed in language which enables them to be shared between interviewees (Commonality Corollary and Sociality Corollary, Kelly, 1955/1963). It was therefore possible to explore individual staff views in the first phase, and then to combine some of these into a tool for more public use in the second phase. Importantly, the staff who would be using the tool, and those from whom the items in it would be generated, would all have completed the Mathematics Recovery training, and would therefore already be using common language for many of the concepts involved.

3.3. METHODOLOGY FOR THE FIRST PHASE: EXPLORING STAFF VIEWS

Initially, it was intended to conduct Personal Construct Psychology (PCP) interviews with six staff, both before and after they completed the MR training, using the Repertory Grid technique. The changes in staff constructs would then be inferred, by comparing the information in the pre and post training grids, for each member of staff. On reflection, and in the light of early pilot work with the interview techniques, this plan was modified. It was decided to conduct the interviews with a larger number of staff, and only to interview after their completion of the course. This decision was taken because the main focus of the study was to be on staff reflection, so that staff perceptions of changes in their own construct systems (which can be accessed by interviewing at the end of the course) were more important than were 'objective' changes (which might be thought to be directly accessible by interviewing both before and after the course). Furthermore, the validity of the construct changes which were self-identified by staff is likely to be higher than that of those which the interviewer would attempt to identify, through examination of pre and post training interview data. A person's construct is what that person experiences it to be, and not what an external interviewer interprets it to be! The process of PCP interviewing is intended to elicit "a description which stays true to the constructs being offered by the other person" (Jancowicz 2004, p15), and so it is the teachers' own descriptions of their changed construct systems which would be valid, rather than an analysis by the investigator of differences in responses given in pre and post course interviews.

3.4. METHODOLOGY FOR THE SECOND PHASE: THE TOOL TO AID REFLECTION

For practical reasons, it was felt that the tool would need to have the format of a brief questionnaire which could be self-completed and self-scored or analysed, by future cohorts of Mathematics Recovery trainees. (There would not be time or opportunity to run individual interviews with these trainees, and the use of the tool would have to be integrated into the delivery of the MR course, probably as an exercise in the last session.)

Various approaches were considered, based on published research methods. Oppenheim (1992) reviews various methods of questionnaire and interview design, and classifies them as either descriptive (such as surveys or censuses, with an emphasis on quantifying pre-defined categories of information) or analytic (with a focus on 'why' questions and on patterns of development, and more emphasis on qualitative explanation). The first phase of the present study employed PCP in an 'analytic' approach, in order to define some constructs which are used in the second phase. The second phase then used a more 'descriptive' design, asking participants to compare their own views with the given constructs. The literature discusses a range of questionnaire tools which can be used to do this kind of job. These include standardised attitude scales, where reliability and validity have been formally researched (Shaw & Wright, 1967) and the Semantic Differential (Osgood, Suci & Tanenbaum, 1967). However, standardised, 'off-the-shelf' tools were judged not to be useful for the present study, as they would be exploring more general attitudes, rather than the specific constructs which emerged in the first phase of the study. It was therefore decided to create a tailor-made questionnaire, using the format of a Semantic Differential, but intended only to be used in this context, and not standardised. A similar approach has often been used in organizational applications, where a phase of detailed PCP exploration is followed by the creation of a tool for a specific purpose, such as a performance appraisal questionnaire (Easterby-Smith, Thorpe & Holman, 1996) or a guidance document (Brophy, 2003).

The constructs which were generated by staff in Phase One have a bipolar form, and previous research has shown that people are generally well able to rate themselves by marking a position on a line between the two poles of such constructs, as in the Semantic Differential format (Fransella, Bell & Bannister, 2004, p8). However, the tool being produced in this study was not to be a true Semantic Differential, as there is no intention to research its factorial structure (Osgood et al, 1967), and it is not necessarily the case that it will measure positions on a unidimensional attitude, as would be the assumption behind a traditional Semantic Differential. The intention here was that staff would use the questionnaire in a qualitative, 'clinical' way, to explore their own changing constructs. A scoring system would be devised, but used mainly to draw staff attention to aspects which have changed, rather than to quantify the degree of change. The questionnaire would be piloted, but with a focus on its content validity, clarity and ease of use, and not in order to try to standardise it.

3.5. RESEARCH QUESTIONS

Having looked at the methods through which the broad aims of the current study were pursued, it is now possible to specify the main research questions, in more detail. These are as follows:

Question 1: What is the range of constructs which Maths Recovery trained teaching staff have about the teaching of number?

Question 2: To what extent are these constructs shared between staff members?

Question 3: To what extent do they reflect the documented principles of the Maths Recovery programme?

Question 4: How do teaching staff perceive that their thinking about the teaching of number develops, following Maths Recovery training?

Question 5: What changes have teaching staff made in their teaching approaches and practices, after receiving Maths Recovery training? What changes are they intending to make?

Question 6: Which concepts/constructs might need to be explored more deeply, in future Maths Recovery courses?

Question 7: Can the identified staff constructs be used to create a tool in the form of a brief questionnaire, which staff will find useful in the process of reflecting on their teaching?

The next chapters will describe in detail how the methodology described above was used to address these research questions. Firstly the method for Phase One of the study will be described, including how the results were analysed, and there will be some discussion of the results from this Phase. This will lead on to a description of the method for Phase two, and of the results from this Phase. The subsequent chapter will then discuss the results as a whole, addressing the aims of the study and the seven research questions above.

CHAPTER 4
PHASE ONE: EXPLORING THE VIEWS OF TEACHING STAFF – PILOT STUDY AND METHOD FOR PHASE ONE OF MAIN STUDY

4.1. INTRODUCTION

This study was in two phases. The first phase involved a systematic exploration of teacher views through a series of individual Personal Construct Psychology (PCP) interviews. The second phase used data from the interviews to design and pilot a tool to aid teacher reflection following MR training. The current chapter focuses on the first phase. It will first describe the pilot work which was carried out, and how the results from this influenced the design of the main study. It will then describe in detail the methods used in the main study, showing how these were analysed and summarised into a format which could be used in Phase Two. The results obtained in Phase one will be discussed in Chapter 5, before going on to describe Phase 2 in Chapter 6.

4.2. PILOT STUDY

An initial pilot study was undertaken, exploring the use of repertory grids to investigate staff constructs about the teaching and learning of number.

4.2.1. Method for Pilot Study

Six staff, who were about to start MR training, were interviewed before they started the training. The author had originally considered interviewing the same staff before and after their MR training. However, only three of the staff actually finished the training. The remaining three staff were all from the same school, which pulled out of the training for unpredictable, managerial reasons. The six staff were interviewed with Personal Construct techniques, using Triadic Elicitation (Fransella & Bannister, 1977 p14) to elicit twelve constructs from each person, on the topic of 'the teaching of number'. The elements used were teachers which the staff nominated, from their present or past experience as teachers or pupils. (Further details of how elements and constructs were elicited and how the grids were completed are given below, in the method for the main study.)

A full repertory grid was completed with each teacher. The interviewer then took this away and analysed it, using several methods. The methods used were:

- Descriptive Analysis, followed by numerical analysis of simple relationships between constructs and between elements (Jancowicz, 2004, chapter 5)
- Cluster Analysis using the REPIV software
- Principal components Analysis, using REPIV

For each interviewee, the interviewer then offered a follow-up session with them, to discuss the meaning of their data.

4.2.2. Results from Pilot Study

Each of the pilot study interviews took approximately 75 minutes. Five interviewees chose to have a follow-up session, lasting about 30 minutes. The author felt that it would not be feasible to use this full procedure both before and after the MR training in the main study. The time demanded from interviewees would be too great, and there was also a likelihood of high sample wastage. The author also reflected upon the nature of the data, and decided that there were strong theoretical reasons (discussed in the previous chapter, section 3.3, p70) why it would be preferable to interview the staff only once, after the completion of their MR training, but to structure the interview so that it caused them to reflect upon how they had changed, as teachers of numeracy. (This could be done by asking them to include as grid elements 'me now' and 'me just before MR training'.)

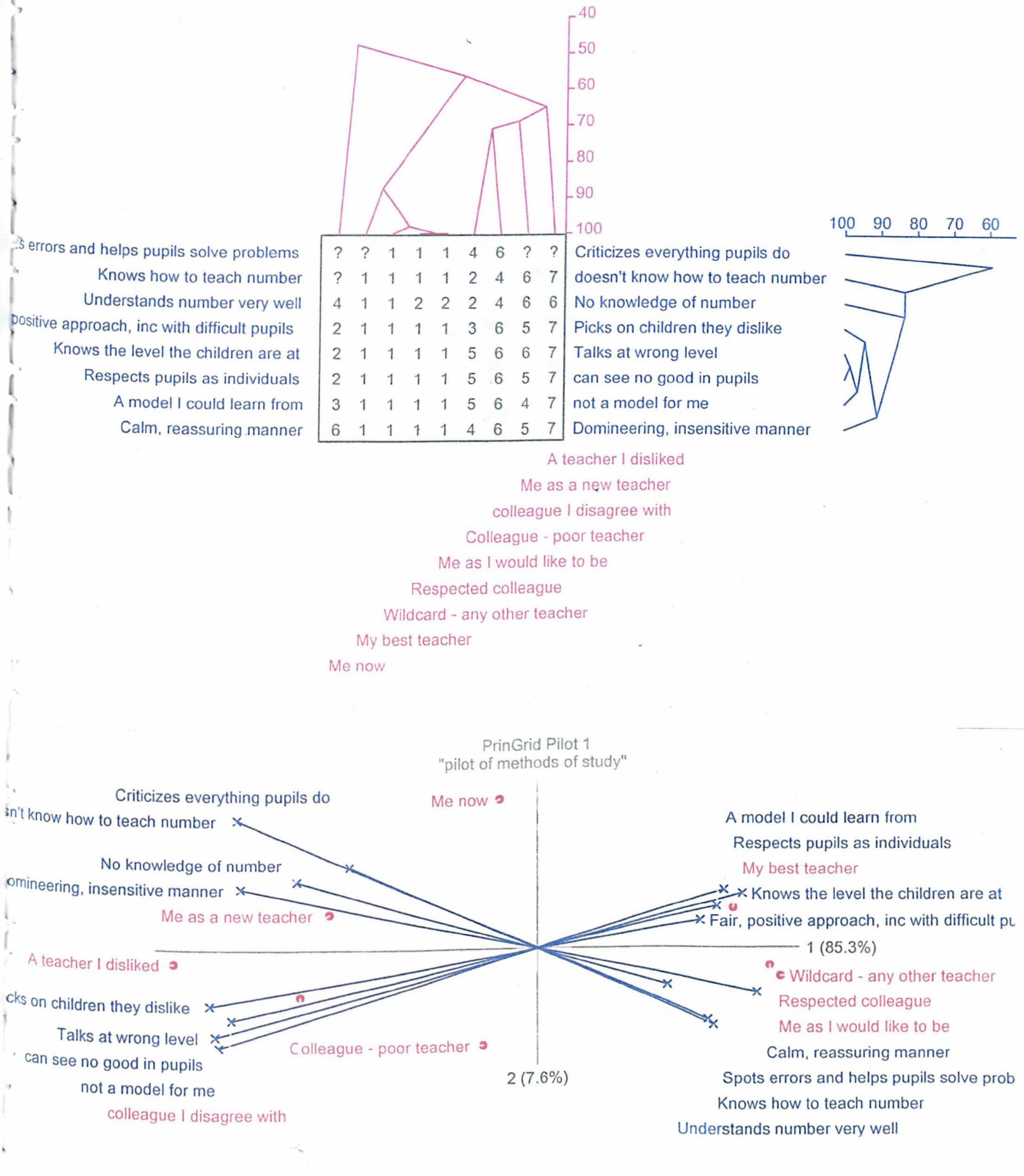
The six interviewees all said that they found the procedure interesting, and several of them said that it helped them to have insights into themselves as teachers. As one teaching assistant said, "I would never have thought we could talk like this about number teaching....so deeply....it's been quite overwhelming...emotional". The pilot study resulted in decisions about how to sharpen up the interview process for the main study, and how the interviews in the main study should be analysed. The decisions taken were as follows:

- A range of additional methods to help in construct elicitation were chosen, to be used when the triadic elicitation was not working well. These are described in the method for the main study (4.3.2.5 below, p89).
- It was decided to elicit fewer contructs from each interviewee, as some of them found it hard to produce 12 distinct ones, and this was impeding the flow of the interview.
- It was decided to interview each participant once, at the end of their MR training. Feedback on the analysis of their interviews

would be offered in written form, with an opportunity for individual follow-up discussion if they wished.

- It was decided not to use the REPIV Cluster Analysis or Principal Components Analysis. The author found that the manual analysis of simple relationships was an effective way of generating a range of hypotheses about the interviewees' constructs, and that reference to the REPIV printouts did not enrich this. Furthermore, the interviewees themselves found the REPIV information difficult to understand, despite attempts from the interviewer to help them to interpret it. (See figure 4.1 below, for sample printouts from REPIV, to elucidate this difficulty, which is discussed in more detail in 4.3.3.3 below, p100.) Instead, the interviewer developed a method of making a verbal summary of the descriptive and simple analysis, which could easily be shared with the interviewee. Details of this are given in the method for the main study, below.

TEXT BOUND CLOSE TO THE SPINE IN THE ORIGINAL THESIS



...s errors and helps pupils solve problems	?	?	1	1	1	4	6	?	?	Criticizes everything pupils do
Knows how to teach number	?	1	1	1	1	2	4	6	7	doesn't know how to teach number
Understands number very well	4	1	1	2	2	2	4	6	6	No knowledge of number
...positive approach, inc with difficult pupils	2	1	1	1	1	3	6	5	7	Picks on children they dislike
Knows the level the children are at	2	1	1	1	1	5	6	6	7	Talks at wrong level
Respects pupils as individuals	2	1	1	1	1	5	6	5	7	can see no good in pupils
A model I could learn from	3	1	1	1	1	5	6	4	7	not a model for me
Calm, reassuring manner	6	1	1	1	1	4	6	5	7	Domineering, insensitive manner

Figure 4.1: Sample Printout from REPIV

4.3. MAIN STUDY

4.3.1. Selection of Interviewees

It was decided that the main study would consist of interviews with a selection of staff who had completed their MR training, and were still working in primary schools within Cumbria. Twenty-eight staff were approached, with the sample being approximately balanced for gender, whether they were a teacher or a teaching assistant, and how recently they had trained. Data about length of teaching experience was not at this stage available, so could not be used. Fifteen staff agreed to participate, and arrangements were made to interview them. Interviews were actually conducted with eleven staff, as will be explained below.

In considering the number of interviews to be conducted, the aims of the research were kept clearly in mind. The first three aims (exploring staff constructs, finding out how these had changed after the MR training and comparing staff constructs with MR principles) required that the sample was large enough to generate a group of constructs which might be considered as representative of the constructs of the wider group of trained staff. However, it was very difficult to predict how many interviews would be required, because of the nature of the data to be collected. The constructs would be expressed verbally, and a qualitative analysis would be needed, in order to compare constructs across staff. It was not possible, using this type of methodology, to predict how many interviews would be required in order to represent the range of staff constructs, or to use a statistical method to determine the required sample size. (Indeed, one might argue that the study can never be finished, as it is always possible that the next interview would generate some novel constructs.) Instead, the decision about how many interviews to conduct was informed by the notion of 'theoretical saturation', taken from the practice of Grounded Theory (Glaser & Strauss, 1999). Here, data is informally analysed and categorized as it is collected, and the researcher stops collecting data when no more new categories or ideas within categories are emerging: at this point, the researcher concludes by pulling together a working theory for future use, derived from the data so far. As Orona says, when describing the process used in one study, "Each of the first three persons I interviewed made essentially the same exact comment.....slowly, four major themes emerged ......I continued with more interviews...." (Orona, 1990).

In the current study, an initial analysis, which is described below, was conducted immediately after each interview. The author reflected upon these as a group, after three, then five, then ten, then eleven interviews had been analysed. The author decided that they contained a wide range of constructs, and that many constructs were shared across interviewees. Very few new constructs were emerging in the last few interviews, and it was felt after eleven interviews had been conducted and initially analysed, that the aims of the study could be addressed sufficiently well with the data collected. The interviewing was therefore ceased at this point.

4.3.2. Running the Interviews with teaching Staff

The twenty-eight staff were contacted by personally-addressed letter, explaining the purpose and nature of the study, telling them what their participation would involve, and asking them whether they would be willing to participate. Replies were requested through email or by post. Interviews were normally arranged at the participants' schools, at times which were individually negotiated. Interviews were conducted with ten teachers and one teaching assistant. Because the study was closely related to the ongoing development of Maths Recovery work in the schools, most of the staff who participated were able to be interviewed during school hours. One member of staff preferred to be interviewed in his own home, outside his working hours. The interviews were conducted using the Repertory Grid Technique, selecting from a range of standard procedures as described in the literature and summarised by Jancowicz (Jancowicz, 2004; Fransella, 2005; Fransella, Bell & Bannister,2004). The steps used are briefly summarised in Appendix B(p257), which the interviewer used as a prompt sheet during the interviews. The steps are described and explained in detail below:

4.3.2.1 Introduction to the interview:

Interviewees were reminded of the length of the interview, assured of freedom from interruptions and of confidentiality of individual responses. They were reminded of the purpose and structure of the study. They were also asked to give permission for an audio recording, which would be destroyed after the completion of the study, to be made. Agreement to these arrangements was checked. The nature of the interview was then explained, describing how their perspectives and ideas would be explored through a series of comparisons. Stress was laid on the following points:

- There were no 'good' or 'right' answers, and the interview genuinely sought to explore their views.
- The interview might prompt staff to think deeply, and to examine constructs which were 'core' (ie of central importance to their beliefs) for them. They were free to engage as deeply as they wished, and to discuss or withhold information as they chose.
- Confidentiality and anonymity would be fully respected, both in the reporting of the study and in any future work with the staff or their school.
- There would be an opportunity for staff to receive a summary of the analysis of their interview, and to discuss this with the interviewer.

4.3.2.2 Introduction of interview topic:

The topic was said to be, 'The Teaching of Number'. A Qualifying Phrase was used, to clarify this, 'How teachers help children to learn: the approach they take, and what they do'. The Topic and the Qualifying Phrase were printed on a card, and left clearly visible throughout the interview. If the interviewee asked for help in focusing their thinking during the interview, the card was used as a reminder.

4.3.2.3 Agreeing the grid Elements:

The interviewee was given a role title, e.g. 'professionally respected colleague', and asked to think of a person in their past or present experience who matched that role. They wrote the name of the person on one side of an element card, which was then folded in half and stood up so that the interviewee could see the person's name, but the interviewer could only see the role title on the other side of the card. This process was repeated eight times, to generate the eight elements for use in the grid. The eight role titles used to generate the elements were:

Me when new to teaching

Me just before Maths Recovery training

Me now

The best teacher I could be

A teacher I disliked

My best teacher

Professionally respected colleague

Colleague I disagree with

4.3.2.4 Eliciting a construct – emergent and contrast poles:

Through discussion, the interviewer elicited from the interviewee one of their constructs about the topic. The main method used was that of Triadic Elicitation (Fransella et al, 2004, p27): three element cards were selected by the interviewer. Two of them were placed side by side, and one a short distance away. The interviewee was asked to think of a respect in which two of them were similar to each other, but different from the third one.

The named similarity was taken to be the emergent pole of one of the interviewee's constructs about the topic. Through discussion, the interviewer checked that she understood the interviewee's construct, and asked the interviewee to express this emergent pole in a short phrase.

The contrasting or implicit pole of that same construct was then elicited. This was done by asking the interviewee to specify what a teacher would be like if they were extremely different from the emergent pole of the construct just generated. Again, the contrast pole was expressed in a short phrase.

Throughout the interview, and especially during the elicitation of constructs, the interviewer made notes on an Interview Notes Sheet (see Appendix C p259), recording the information generated, the techniques used, and the interviewee's comments and reactions. These notes, together with reference to the audio recordings of interviews where necessary, could be used later to aid interpretation of the interview data.

4.3.2.5 Checking the level of the construct:

The interview and interviewee considered whether the construct generated was suited to the purposes of the grid: did it express something which the interviewee felt was a relevant, non-trivial construct for him? If not satisfied, then the interviewee would modify the construct, or abandon it and start again with a new triad of elements.

Sometimes, the interviewee would get stuck in generating constructs. The Interviewer then offered some alternative ways of generating constructs. These alternative ways are described in detail in

Appendix D, 'PCP Interview on the Teaching of Number: Prompt notes' (p260), and are briefly summarised below:

- 'Laddering' downwards or upwards, to arrive at a construct which is at a more suitable level. Laddering down was used to arrive at a more specific and detailed construct, if the original one was unhelpfully global. Laddering up was used to arrive at a more superordinate or core construct, if the original one was unhelpfully specific. (See Fransella, 2003 pp112-118; Fransella at al, 2004, p39; Butt, 2007.)
- Pyramiding, to produce an extended range or variety of constructs. This was used where the interviewee had generated a construct which was important for them, and was finding it hard to move on from this and generate other constructs. It resembles 'laddering down', but explores all the constructs which flow from the original one, producing an expanding pyramid of related constructs, rather than a single ladder. From the pyramid, the interviewee is encouraged to focus on and develop a construct which is distinctly different from the original one. (See Jankowicz, 2004, p67 and Fransella et al, 2004, p 43.)
- Producing a Character Sketch. This is a way of generating constructs independently of the list of elements, and it was used if the interviewee appeared to

be getting stuck or irritated with working with the set of elements. The interviewee was asked to imagine how someone else (a pupil who values them as a teacher) would describe them. This brief 'pen portrait' was then used as a focus for discussion, from which the constructs were drawn. (Jancowicz, 2004, p59; Denicolo, 2005, p59.)

4.3.2.6 Rating the elements on the generated construct:

Starting with the triad of elements which had been used to generate the construct, the interviewee was asked to rate each of the elements according to that construct, on a scale of 1 to 5. The emergent pole was represented by 1, and the contrast pole by 5. A cardboard scale was used as a visual aid, and the interviewer checked that the interviewee appeared to be using the scale correctly (i.e. that the two elements which had been used to generate the construct received low ratings, and the third element received a higher one.)

The constructs which had been generated, together with the ratings for elements, were recorded by the interviewer on a Grid Record Form (see Appendix E p262, for a blank form and a sample completed form for Interviewee number 3). It can be seen that, by recording the constructs on this form, each construct is allocated a unique number, which enables it to be tracked back to the interviewee who generated it, at any point in the later analysis. For example, construct number 8.6 would be the sixth construct generated by interviewee number eight.)

4.3.2.7 Generating and rating elements on nine constructs:

The steps from 4.3.2.4 to 4.3.2.6 were repeated, until eight distinct constructs, which the interviewee agreed were meaningful and significant for him, had been generated and each of the elements had been rated on each of the eight constructs. The interviewee was then asked to rate the elements on a ninth construct, which was donated by the interviewer. This construct was intended to be an overall Summary Construct, and was phrased as, 'Teaches numeracy very well' (emergent pole) versus 'teaches numeracy very poorly' (contrast pole). This summary Construct was included in order to enable later analysis across the grids of different interviewees, as will be described below.

4.3.2.8 Checking importance of constructs:

Once all nine sets of ratings were completed, the interviewee was asked to consider them as a group, and to try to rank order them according to how personally significant or important they were, i.e. whether they were core constructs or more peripheral, in the interviewee's system of constructs about the topic. This activity offered the interviewee an opportunity to check that he was happy with the constructs which had been elicited, and that the words which had been used to record them did adequately capture the meanings.

4.3.2.9 Discussing changes in practice:

The interviewee was asked whether they had made, or intended to make, any changes in their teaching practices, following their MR training. Responses were explored through discussion, and recorded on the Interview Notes Sheet.

4.3.2.10 ***Concluding the interview:***

The interviewee was given an opportunity to ask questions or discuss concerns, and was reminded of arrangements for follow-up dialogue (i.e. they would be sent brief, written feedback, and would have an opportunity to discuss either in person or by telephone). They were thanked for their participation, and the interview was concluded.

4.3.3. Initial Analysis and Feedback to Staff

Immediately after each interview, the author conducted an initial analysis, using the notes made at the interview, the information on the Grid Record Form and referring to the audio recording if necessary. This analysis had two main purposes. Firstly, it was intended to help the author to make sense of the interview data, and to locate and summarise the parts of it that were relevant to the questions being asked in the study. Secondly, it was intended to help the interviewee to reflect upon what they had said in their interview, and to give them an opportunity to use it to help them develop their thinking. The analysis therefore proceeded at several levels: first, the author analysed the data in various ways, then, within a week of conducting each interview, the feedback to the interviewee was prepared and delivered. Any interviewee responses to the feedback were then incorporated into the analysis.

- ***Descriptive analysis:***

  The first type of analysis which was undertaken was a descriptive analysis of the grid, similar to that recommended by Jankowicz (Jankowicz 2004, chapter 5, pp 71 –89). Prior to any systematic numerical analysis of the grid, the author reflected upon the nature of the information in the interview, and made notes on the following aspects:

- The interviewee's reaction to the topic, including level of engagement.
- The elements: how readily these were generated and how comfortable the interviewee was with doing this; how relevant to the topic they proved to be.
- The constructs: any novel or difficult constructs; the way different elicitation methods were used; how easily they were elicited; the nature of constructs elicited (affective, behavioural, evaluative, attributional, constellatory or pre-emptive)
- The ratings: how easily these were made; whether the interviewee found the task meaningful.
- Relationships between the elements, and between the overall Summary Construct and the elements: initial comments about how the different 'self' elements are rated, and how these relate to the overall construct.

Following the above analysis, which combines steps from Jankowicz's 'process analysis' and his 'eyeball analysis' (Jankowicz, op cit), it was possible to formulate some initial interpretations and conclusions from the interview data. Appendix F, Initial Individual

Grid analysis Sheet (p260), contains a completed sample of analysis notes for one interviewee.

4.3.3.2 Analysis of simple Differences:

The second type of analysis used was a numerical analysis of the relationships within the grid, using simple differences between elements, and between constructs (Jancowicz, op cit, p96). This analysis will be explained below, using the results from one interview to illustrate the process. The reader will need to refer to these results, which are given as Figure 4.2 (Grid Record Form for Interview 7), Figure 4.3 (Analysis of Individual Grid for Interview 7) and Figure 4.4 (Discussion of Analysis of Similarities for Interview 7).

Figure 4.2: Grid Record form for Interviewee 7

TOPIC: **The Teaching of Number**

QUALIFYING PHRASE: **How staff help children to learn: the approach they take, and what they do**

(most important)

	1 Me when new to teaching	2 Me just before MR training	3 Me now	4 The best teacher I could be	5 A teacher I disliked	6 My best teacher	7 Professionally respected colleague	8 Colleague I disagree with	
(2) 7.1 2&1 7 ~~He~~ Constantly improves teaching skills through experiences	2	2	1	1	5	1	2	3	has not improved teaching through experience — 'stuck in a rut'.
	4	4	5	5	1	5	4	3	
7.2 (2&1 vs 7). Perceives only only one way of teaching something.	3	4	5	5	2	5	4	3	Keeps trying different methods to find one that works. * (1)
	3	2	1	1	4	1	2	3	
7.3 8&5 vs 2. ~~Teaches topics~~ as an entity – doesn't think of breaking things down.	3	4	5	5	2	5	4	5	Breaks work down, to make it easy for children to learn. (3)
	3	2	1	1	4	1	2	3	
(6) 7.4 (4&8 vs 5) Encourages child talk & activity in class.	3	3	3	3	1	2	3	2	'Heads down, silent worksheets'.
	[illegible]	[illegible]	3	3	5	4	3	4	
(4) 7.5 (4&8 vs 5) Knows what she wants children to learn, and designs structure to lead there.	5	3	3	3	5	4	3	5	~~Lacks organised thinking~~ Direct teaching of skills.
	1	3	3	3	1	2	3	1	
(5) 7.6 Has empathy for pupils' problems & feelings.	3	1	1	1	5	1	2	4	Attributes pupil difficulties to lack of ability.
	3	5	5	5	1	5	4	2	
(8) 7.7 Able to quietly set and maintain behavioural standards in class.	2	3	3	1	1	1	2	5	Finds it difficult to maintain discipline.
	4	3	3	5	5	5	4	1	
(7) 7.8 Enthusiastic about the subject.	1	2	2	1	4	2	2	4	Just teaching it because they have to.
	5	4	4	5	2	4	4	2	
7.9 Teaches numeracy very well	3	3	2	1	4	3	2	4	Teaches numeracy very poorly

Name.................................... **No** 7 **School** Warwick B...........................

Date 05/12/05 ....**Date MR training completed** Spring ... **Teacher/TA**... (27yrs exper. SN teaching (mostly 1-1) for last 13 yrs.)

Figure 4.3: analysis of Individual Grid for Interviewee 7

ANALYSIS OF INDIVIDUAL GRID Interviewee No: 7 Date: 05 12 05

Constructs

1	Constantly improves teaching skills through experiences	⟷	Has not improved teaching through experience – stuck in a rut
2	Perceives only one way of teaching something	⟷	Keeps trying different methods to find one that works
3	Teaches topics as an entity –doesn't think of breaking things down	⟷	Breaks work down to make it easy for children to learn
4	Encourages child talk & activity in class	⟷	Heads down, silent worksheets
5	Knows what she wants children to learn, designs structures to lead there	⟷	Direct teaching of skills
6	Has empathy for pupils' problems & feelings	⟷	Attributes pupil difficulties to lack of ability
7	Able quietly to set & maintain behavioural standards in class	⟷	Finds it difficult to maintain discipline
8	Enthusiastic about the subject	⟷	Just teaching it because they have to
9	Teaches numeracy very well	⟷	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns) / *ONE CONSTRUCT REVERSED* (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		20	20	13	14	3	9	5	7
2	2		0	11	14	21	17	19	15
3	2	18		11	14	21	17	19	15
4	11	11	11		11	14	8	12	10
5	14	14	14	3		13	13	13	9
6	23	3	3	10	17		10	6	6
7	17	9	9	10	9	18		8	8
8	21	5	5	10	11	22	18		4
9	17	5	5	6	13	18	14	16	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		8	12	12	14	11	7	9
2	Me just before MR training			4	8	21	7	3	14
3	Me now				4	24	5	5	18
4	The best teacher I could be					24	5	7	22
5	A teacher I disliked						19	19	10
6	My best teacher							8	16
7	Professionally respected colleague								15
8	Colleague I disagree with								

Figure 4.4: Discussion of analysis of similarities for Interviewee 7

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 7 Date: 05 12 05

The interviewee thought deeply during the session, taking some time and effort to articulate her constructs. She found some aspects difficult: it was hard for her to nominate the negative elements (5 & 8), and for her to generate ratings for the elements which were aspects of herself (elements 1,2 & 3). Triads were found quite helpful in the elicitation process, and use was made of laddering upwards and laddering downwards, when it was hard to generate new constructs.

In looking at the relationships between constructs, we see a tight cluster of constructs which are associated with the overall construct 'teaches numeracy very well' (9). This cluster includes construct 6, 'has empathy for pupils' problems & feelings'; construct 8, 'enthusiastic about the subject'; construct 1, 'constantly improves teaching skills'; construct 2 reversed, 'keeps trying different methods to find one that works'; construct 3 reversed, 'breaks work down to make it easy for children to learn'. When asked to say which of the constructs were most important for her idea of good teaching, she said that 1, 2 reversed and 3 reversed were most important, but that all of them make an important contribution.

> ***For this interviewee, good numeracy teachers are those who constantly improve their teaching skills through experience. To achieve this, they try out different methods to find ones which work, and they base their methods on breaking the work down into tasks which are easy enough for the children to do. These teachers are enthusiastic about teaching maths, and they see the pupils as able to succeed. They have empathy for pupils' feelings and difficulties. they are also able to maintain discipline in the classroom.***

Looking at relationships between the grid elements, we see that the elements 'me now'(3), 'the best teacher I could be'(4), 'my best teacher'(6) and 'professionally respected colleague'(7) are rated similarly on the constructs as a whole. 'The best teacher I could be'(4) is rated similarly to 'my best teacher'(6). On the other hand, 'the best teacher I could be'(4) is seen as very dissimilar to 'a a teacher I disliked'(5) and 'colleague I disagree with'(8). Thus:

> ***This teacher has a positive view of herself as a teacher of numeracy, believing that, after 27 years experience, she is quite close to being as good as she can be. She believes she could still improve her classroom discipline (perhaps because she is out of practice at handling whole classes, as she currently works mainly with individual pupils), and that she could be even more enthusiastic about numeracy than she currently is. Despite her long experience, she feels she has shown improvements since her Maths Recovery training, and that these improvements are in the three most important aspects of the teaching: learning through experience(1), evolving new methods(2) and breaking tasks down for children(3). She says that, although she has always had empathy for children's' difficulties, she now knows more about what to do in order to help them.***

Figure 4.4 (cont.)

She describes some changes which she has made to her practice, as a result of the Maths Recovery training:

- Improved content of individual programmes: these are now more structured, and are planned so as to comprise targets and activities which will build up skills from a known baseline.
- A fundamental change of approach, with an emphasis on leading children towards understanding. She now tries to find a way to lead children to discover methods of solving problems, rather than teaching them mathematical methods, which they may not understand.
- She works in two different school, and she does individual Maths Recovery programmes in each school. All pupils with Statements of Special Educational need for learning difficulties are given MR programmes.
- She has adapted the MR programmes, to include more written responses: this was done in order to help the programmes to generalise into the mainstream classroom.

For the elements, this procedure involved constructing a matrix which showed how similarly rated to each other the elements were. To do this, each possible pair of elements was compared, to see how similarly rated they were on each of the constructs. The difference between their ratings on each of the 9 constructs was summed, to give an indication of how similar the interviewee perceived the two elements in question to be, when considered in terms of the constructs on the grid. For example, in Figure 4.2, in order to compare the ratings of elements 1 and 2 the calculation would be: (2-2)+(4-3)+(4-3)+(3-3)+(5-3)+(3-1)++(3-2)+(2-1)+(3-3)=8. So the value of 8 was entered on the Similarities between Elements matrix at the bottom of Figure 4.3. The rest of this matrix was similarly completed, and used to help generate hypotheses about the interviewee's construct system. For example, in Figure 4.3, the Similarities Between Elements table shows a low value of 3 for the relationship between element 2 (Me just before MR training) and element 7 (Professionally respected colleague), suggesting that these elements are seen as being very similar to each other. One might hypothesize about why the value is low: perhaps this teacher has a high self-esteem about their teaching, and models themselves on respected colleagues. Such hypotheses were used in the generating of a verbal description of the data, for feedback to and discussion with the interviewee. (See Figure 4.4 'Discussion of analysis of similarities: Interviewee No. 7' , and also the further details of this stage of data analysis in 4.3.3.3 below.)

A similar analysis of simple differences was performed for the constructs, and is summarised in the 'Similarities Between Constructs' matrix in Figure 4.3. The figures in this matrix were obtained by considering each pair of constructs in turn, and summing the absolute differences between their ratings across the eight elements. Thus, a high score would mean that the interviewee thought the two constructs were very different, in terms of how they applied to teachers from their experience (i.e. the elements). A low score would mean that, in terms of how the interviewee viewed the teachers chosen as elements, the two constructs went together closely. It will be noted that, unlike the Similarities Between Elements matrix, the Similarities Between Constructs matrix has entries both above and below the diagonal, and is not symmetrical. This is because, unlike the elements, the constructs have two poles. Although the two poles of a construct are contrasting, they are not 'opposites' in the sense of one being mathematically the complement of the other. Rather, this needs to be explored by considering the relationships between each construct and both the emergent and the contrast pole of each other construct. An example will clarify this point. Looking at constructs 8 and 9 in Figure 4.3, one sees a low value of 4 for the relationship between construct 9 and construct 8, and one might expect a high value for the relationship between constructs 9-reversed and 8. However, this value, at 16, is not particularly high. The reason for this is easily understood, when referring to the meaning of the constructs: the interviewee is telling us that, in her view, teachers who are enthusiastic about the subject generally teach numeracy well: however, she thinks that, if you just teach it because you have to, you might also teach it well.

Further details and examples of the analysis techniques used for the individual grids are given in Jankowicz (2004), chapters 5 and 6.

4.3.3.3 Feedback and Discussion with Interviewees

Values of these simple differences which appeared, by inspection, to be particularly high or particularly low within the interviewee's two matrices were highlighted, for qualitative discussion in the light of the descriptive analysis. The descriptive analysis and the initial numerical analysis were then combined, to create a feedback sheet for the interviewee. (See appendices G(1) to G(11), pp266-298, Discussion of Analysis of Similarities, for a completed sheet for each interviewee.) The format of this sheet developed during the study: initially it varied in length and format, but by the fourth interview the author had developed a standardised format, which was found to be easier to compose, and interviewees said they found easy to understand. This format contained the following elements:

- Summary comments on the interview process, including affective aspects and particular difficulties experienced by interviewees.
- Comments on the nature of the constructs generated, and the relationships between them. By looking at the relationships of the other constructs to the overall

Summary Construct of 'teaches numeracy very well', it was possible to write a paragraph which sketched the interviewee's construction of what a good numeracy teacher would be like. This was regarded as a key paragraph, and was written in bold type.

- Comments on the relationships between elements. By looking at the relationships between 'Me when new to teaching', 'Me just before MR training', 'Me now' and 'the best teacher I could be' it was possible to write a sketch of the interviewee's view of themselves as a numeracy teacher, and of how that has changed since the MR training. Again, this was regarded as a key paragraph, and was written in bold type.
- A summary of the information which the interviewee gave about any changes in their practice of teaching, which they had made or which they intended to make, since the MR training.

The feedback sheet was sent to each interviewee, a few days after their interview, with an invitation to contact the author by telephone or email, in order to arrange a discussion if desired. Following such discussions, any agreed amendments were made to the feedback sheets, to produce the final versions given in appendix G.

This method of feeding back to interviewees was developed over the course of this study, through work during the pilot study and with the first interviewee in the main study. Initially, the author experimented with using a more detailed and formal numerical analysis, in the form of a Principle Component Analysis, generated through the REPIV computer programme. (See Figure 4.1 on p 83 for a sample printout from one pilot interviewee.) However, it was found that this analysis was very difficult for the interviewees to interpret meaningfully. In the cluster analysis printout (upper section of Figure 4.1), it was difficult to explain to interviewees the meaning of the network of lines and their associated percentage values, which links the elements and constructs into hierarchically ordered clusters. In the Principle components Analysis (lower section of Figure 4.1), it was difficult to explain the derivation and meaning of the two axes, and how to interpret the distances between items on the diagram. In order to make sense of either of these Figures, the interviewees would need to have an understanding of cluster analysis and Principle Components Analysis: this would not be expected of teaching staff in their position, and it was judged that explaining it to them would be a time-consuming distraction from the focus of the study. Furthermore, the author found that the process of manually performing a simpler numerical procedure was very helpful in facilitating reflection on the meaning of the data, from which emerged ideas for feedback to the interviewees. Thus the simpler numerical analysis, together with the qualitative information, could more easily be used to formulate meaningful hypotheses to feed back to interviewees and discuss with them.

4.3.4. Analysis of Data across Interviews

The method chosen for this was Honey's content analysis, as described by Jankowicz (Honey, 1978; Jankowicz, 2004, pp173 - 184). This method uses the presence of the same overall Summary Construct in each grid, to enable the aggregation of constructs across the grids. The steps which were used in this analysis can be summarised as follows:

- **Step 1:**

  The individual grids were prepared, by labelling each construct with two indices. The first index was the 'percent similarity' of the construct to the overall summary construct. This was calculated using the formula (from Jancowicz, 2004 p175):

  $$100 - [(SD/\{(LR-1) \times E\}) \times 200]$$

  where:

  SD is the absolute sum of the differences between ratings for the construct under consideration and the overall construct. (These were calculated as described above.)

  LR-1 is the largest possible rating, minus one: i.e. 5-1, which is 4

  E is the number of elements, ie. 8

  This statistic indicates, on a scale of +100 to –100, how similar the particular construct was to the Overall Summary Construct 9: a score of +100 would mean that the interviewee had rated all the elements on that construct the same as they rated them on the overall summary construct, and a score of –100 would mean that those two sets of ratings were as different as possible.

  The second index, know as the HIL Index, reflects how an individual interviewee perceived the relative contribution of each construct to the overall summary construct. This index was computed simply by, within each grid, dividing the percent similarity scores into the highest, middle and lowest third, and labelling each one as H, I or L. Thus, a construct could have a high first index, because the interviewee felt that good teachers do usually score highly on the construct, but a low second index, because the interviewee, who gave high ratings to many constructs, felt that this construct was actually less important to good teaching than were many of the other constructs which they generated. Use of these two indices enabled some information about individual interviewee's views to be retained, even after the constructs were aggregated across interviews.

- **Step 2:**

  A content analysis was made by the author, of the material from all eleven grids, using the Core-categorisation procedure (Jankovicz, 2004, p149). This procedure, which was originally described by Holsti (1968), has the following steps:

  - The constructs from all eleven grids were put onto separate slips of paper (labelled so that it was still possible to tell which interviewee each one came from).
  - Two constructs were selected, and compared. It the author felt they were alike in some significant way, she created a category for them, by placing them together. If

she felt they were not alike, she placed them in two separate categories.

- The remaining constructs were compared with each of the categories, and allocated to an appropriate category where possible.
- Where there was no appropriate category for an item, a new category was created. Each time this was done, the author reviewed the previously-allocated items, and sometimes needed to reorganise existing categories, by merging or breaking them up, and reallocating previous items.
- This process was continued, until all items were allocated. Where items were on their own in a category, they were combined to make one 'miscellaneous' category. However, if more than 5% of the items were in this 'miscellaneous' group, then the category system was reviewed and revised, to reduce the number.

This resulted in a set of categories, with each construct assigned to a category. (See Table 4.1 on p111, Content Analysis Table, Interviewer's Initial.) There were 88 constructs in this table, in 17 categories, with no items in the 'miscellaneous' category.

- **Step 3:**

A similar content analysis was made independently by a colleague. This colleague did not have detailed knowledge of Maths

Recovery, but had some experience in the qualitative analysis of interview data. (See Table 4.2 p113, Content Analysis Table, Colleague.

- **Step 4:**

  A reliability table was compiled, to see what percentage agreement there was between the author's table and the colleague's table. (See Table 4.4 p304, Initial Reliability Table). This procedure was used as a check on the reliability of the judgements which the author made about how to categorise the interviewees' responses: a high agreement between author and colleague would suggest that the judgements were consistent and capable of being shared by a wider group of people.

- **Step 5:**

  The author and colleague discussed the similarities and differences between the two tables, focusing on the meaning of the language being used, and referring to the two indices to help in resolving difficulties. They then agreed on a common set of categories.

- **Step 6:**

  The author and colleague each repeated, independently, the content analysis, using the new set of categories. A new reliability table was then compiled. Steps 5 and 6 were repeated, aiming to reach a reliability Index of at least 90% . (See Table 4.5 p311, Final Reliability Table.) In fact, a Reliability Index of 95.2% was achieved after one repeat of the content analysis.

- **Step 7:**

  At this point, the author's content analysis table was adopted as the final table. (See Table 4.3 p115, Content Analysis Table, Interviewer's Final Version). In this table, each category was given a brief title, agreed by the author and colleague. The constructs within each category were listed, and the author wrote definitions for each category, by summarising the ideas from all of the constructs within that category. The final column of the table gives the numbers of constructs which fell within each category, and the percentage of the constructs which that represented.

4.3.5. Concluding Comments

The author found the Final Content Analysis table very useful, in discussing the meaning of the data from the group as a whole. It will be noticed, however, that at this stage the Percent similarity and HIL indeces have not been taken into account. That will be done in Phase 2, which is described in Chapter 6.

At this point, the data have been analysed, both for individual interviews and across the group of interviews. Before describing how the data was used in Phase 2 of the study, the next chapter will discuss the results so far, and how they shed light on the research questions which were posed in Chapter 3.

Table 4.1 CONTENT ANALYSIS TABLE: interviewer's initial

Category	**Definition**	**Constructs**	**Sum %**
Empowering children towards independent learning	Supporting children towards independent learning ***versus*** directing or 'spoon-feeding' them; Using open-ended tasks, facilitation and pupil choice, ***versus*** telling children how to solve tasks; Uses questions and discussion, ***versus*** silent written work.	2.8, 8.8,10.2,6.7 1.8, 3.8, 7.5,10.7 4.7, 7.4, 8.6, 11.4	12 13.64%
Following plans inflexibly	Using familiar plans and methods inflexibly, ***versus*** working in new ways, being open to change; Changing plans in response to pupil need, ***versus*** rigidly following plans; Perceiving only one way to teach something, ***versus*** trying out different ways.	1.1, 3.3, 4.4 11.5 7.2	5 5.68%
Assessing what individual children can do	Structuring assessment, and relating it to teaching, ***versus*** vague, purposeless assessment; Making ignorant assumptions about what children can do, ***versus*** skilful analysis of what they actually do.	9.3 6.2, 8.7	3 3.41%
Differentiating to match tasks and teaching methods to child	Choosing next step according to child's knowledge, ***versus*** using next step from the curriculum; Providing differentiated tasks and support whilst teaching, ***versus*** using generic lessons or linear scheme.	4.2, 6.8, 10.8 2.7, 5.2, 6.1,8.2, 9.8	8 9.09%
Knowing about number	Having good knowledge of number, ***versus*** poor knowledge of number.	1.6, 5.3, 4.5, 9.4, 10.5, 11.3	6 6.82%

Category	Definition	Constructs	Sum %
Knowing how children learn number	Knowing about the course of the development of children's learning of number, ***versus*** not understanding their development, relying on age-related expectations.	2.3, 5.4, 8.3, 9.2, 11.2	4 4.55%
Having a range of teaching ideas and methods	Having a wide range of teaching methods, equipment and strategies, ***versus*** having just one way to teach each thing.	5.8, 10.4, 11.6	3 3.41%
Managing behaviour in class	Having good behaviour management, ***versus*** poor discipline, chaotic classroom..	2.4, 5.7, 7.7	3 3.41%
Deriving teaching strategies from an understanding of how to teach number	Understanding how to teach number, ***versus*** not understanding how to teach number; Going back to earlier stages, and breaking work down into easier tasks, ***versus*** just repeating methods which have not worked for a child.	4.6 5.5, 7.3	3 3.41%
Teacher motivation and commitment	Being committed to the job: trying hard, and wanting to teach number, ***versus*** not interested in the job; Believing that maths is important and should have time spent on it, ***versus*** spending minimum of time on it; Wanting children to succeed and to enjoy maths, ***versus*** just wanting their own pay.	1.3, 2.1, 3.6, 9.5, 2.2 6.3 4.8, 9.6,7.8	9 10.23%

Category	Definition	Constructs	Sum %
Helping children to enjoy success in maths, through positive methods.	Wanting children to enjoy lessons and build confidence through success, ***versus*** lack of interest in children's enjoyment; Making lessons fun through creative and lively teaching, ***versus*** motivating by fear, getting cross and putting pressure on children; Being approachable – patient, calm, positive, jovial ***versus*** being impatient, cross, serious, frightening.	2.6, 5.1, 6.7, 8.4 1.4, 1.5, 3.2, 10.1, 11.8 3.7, 6.5, 6.6	12 13.64%
Respect for children: empathy and high expectations	Expecting that children will be able to understand, versus having low expectations of children's abilities; Empathising with children and supporting them with difficulties, ***versus*** blaming them for their difficulties.	8.1, 8.5 3.1, 4.1, 5.6, 7.6	6 6.82%
Teacher development	Seeking to improve as a teacher, by reflecting on new experiences and ideas, ***versus*** 'stuck in a rut', closed to new ideas.	3.5, 7.1, 9.7, 10.6	4 4.55%
Structuring and organising lessons	Structuring and pacing lessons well, ***versus*** haphazard, disorganised approach.	2.5, 4.3, 11.1, 11.7	4 4.55%
Teacher wisdom	Experienced and knowledgeable, with well-developed ideas about teaching, ***versus*** inexperienced and naïve about teaching.	1.7, 3.4, 9.1	3 3.41%
Teacher confidence	Feeling confident and contributing to plan, ***versus*** feeling insecure and not contributing to planning.	1.2, 6.4, 10.3	3 3.41%
Miscellaneous			0 0%
		TOTALS	88 100%

Table 4.2: CONTENT ANALYSIS TABLE: Colleague

Category	**Definition**	**Constructs**	**Sum %**
Knowledge of maths	Having a thorough understanding of maths vocabulary & in-depth knowledge of number, ***versus*** not knowing the subject.	1.6, 4.5, 4.6, 5.3, 9.4, 10.5, 11.3	7 7.95%
Confident, organised manner	Confidence deriving from good structure and flexibility, ***versus*** poor planning and rigidity.	2.5, 4.3, 7.5, 11.1, 11.5	5 5.68%
Teaching style and personal classroom manner	Patience to retrace and re-approach, ***versus*** unwillingness to do so.	3.7, 4.7, 5.5, 7.2, 8.2, 11.6	6 6.82%
Differentiating in respect of children as individual learners	Seeing class as distinct individuals with separate learning needs, ***versus*** seeing the class as a herd.	2.7, 4.2, 5.2, 9.3, 10.8	5 5.68%
Allowing children to function with degrees of independence	Allowing children some independent freedoms, ***versus*** totally directing them.	2.8, 7.4, 8.6, 8.8, 10.7	5 5.68%
Confidence to be flexible	Having confidence to be willing to change, from their experience of teaching, ***versus*** reluctance to let go of rigidly held beliefs.	1.2, 3.3, 3.4, 4.4, 6.1, 6.4, 9.1, 10.3	8 9.09%
Professional conduct of lesson	Well-paced lessons and a suitably jovial manner, ***versus*** confused and sloppy lessons, delivered in a defensively serious manner.	1.7, 3.8, 6.5, 10.1, 11.7	5 5.68%
Classroom management	Good behaviour management, ***versus*** chaotic/poor discipline.	2.4, 5.7, 7.7	3 3.41%
Ability to empathise with children	Empathises with child, ***versus*** low expectations.	3.1, 7.6, 8.5	3 3.41%

Category	Definition	Constructs	Sum %
Motivates children to learn	Inspirational facilitator, ***versus*** rules by fear.	1.5, 1.8, 3.2, 5.1, 6.6, 8.4	6 6.82%
Understanding how children learn number	Having a sound understanding of how children learn number, ***versus*** no knowledge of how children learn number.	2.3, 5.4, 6.8, 8.3	4 4.55%
Understanding how children learn	Understands the structure of children's learning, ***versus*** doesn't know how children learn.	7.3, 8.1, 8.7, 9.2,11.2	5 5.68%
Feels working with children is important	Tries to give children their absolute best, ***versus*** no enthusiasm or tolerance.	1.3, 4.1, 6.2, 9.5, 9.6	5 5.68%
Happy classroom performer	Committed to making lessons fun and interesting, ***versus*** marking time.	1.1, 2.1, 3.6, 7.1, 11.4,11.8	6 6.82%
Reflective, inspirational practice	Reflects positively on teaching, ***versus*** lacks motivation, disillusioned.	1.4, 2.2, 3.5, 5.6, 9.7, 10.6	6 6.82%
Wants children to achieve independence	Wants children to be confident with maths by themselves, ***versus*** wants children to sit and listen	2.6, 5.8, 6.7, 10.2	4 4.55%
Maths is most important subject in school	Believes that maths is very important and enthusiastically spends much time on it, ***versus*** just teaching it because they have to.	4.8, 6.3, 7.8, 9.8, 10.4.	5 5.68%
Miscellaneous			0 0%
		TOTALS	88 100%

Table 4.3: CONTENT ANALYSIS TABLE, INTERVIEWER'S FINAL VERSION

Category	**Definition**	**Constructs**	**Sum %**
Knowing about number	Having good knowledge of number, ***versus*** poor knowledge of number.	1.6, 4.5, 5.3, 9.4, 10.5, 11.3	6 6.82%
Helping children to enjoy success in maths by positive methods	Wanting children to enjoy lessons and build confidence through success, ***versus*** lack of interest in children's enjoyment; Motivating children through fun & enthusiasm ***versus*** motivation through pressure & fear.	2.6, 5.1, 8.4 1.5, 3.2, 6.6, 10.1, 11.8	8 9.09%
Empowering children towards independent learning	Supporting children towards independent learning ***versus*** directing or 'spoon feeding' them; Using open-ended tasks, facilitation and pupil choice, ***versus*** telling children how to solve tasks; Using questions and discussion, ***versus*** silent written work.	2.8, 6.7, 8.8,10.2 1.8, 3.8, 7.5, 10.7 4.7, 7.4, 8.6	11 12.5%
Differentiating to match tasks and teaching methods to child	Choosing next step according to child's knowledge, ***versus*** using next step from the curriculum; Providing differentiated tasks and support whilst teaching, ***versus*** strict use of generic lessons or linear scheme; Skilful assessment of what individuals actually do and know, ***versus*** unstructured observations and ignorant assumptions.	4.2, 10.8 2.7, 5.2, 6.1, 8.2, 9.8 6.2, 8.7, 9.3	10 11.36%
Valuing working with children	Committed to and excited by helping children, ***versus*** just wanting their own pay;	1.3, 9.5, 9.6	3 3.41%

Category	Definition	Constructs	Sum %
Enthusiastic commitment to teaching	Believing that maths is important and should have time spent on it, ***versus*** spending minimum time on it; Being committed to the job: trying hard and wanting to teach number, ***versus*** not interested in the job;	4.8, 6.3, 7.8 2.1, 2.2, 3.6	6 6.82%
Understanding how children learn	Understands how children learn, ***versus*** poor understanding of children's learning.	9.2, 11.2	2 2.27%
Knowing how children learn number	Knowing about the course of development of children's learning of number, ***versus*** not understanding their development, but relying on age-related expectations.	2.3, 5.4, 6.8, 8.3	4 4.55%
Respect for children – empathy and high expectations	Expecting that children will be able to understand, ***versus*** low expectations of children's abilities; Empathising with children and supporting them with difficulties, ***versus*** blaming them for their difficulties.	8.1, 8.5 3.1, 4.1, 7.6	5 5.68%
Structuring and delivering organised lessons	Structuring and pacing lessons well, ***versus*** haphazard, disorganised approach; Deriving teaching strategies from understanding of number, ***versus*** unable to break number work down into teachable segments; Changing plans according to pupil need, ***versus*** rigidly following plans.	2.5, 4.3, 11.1, 11.7 4.6, 5.5, 7.3 11.5	8 9.09%
Teacher development	Seeking to improve as a teacher, by reflecting on new experiences and ideas, ***versus*** 'stuck in a rut', closed to new ideas; Experiments with teaching: tries to 'unstick' pupils with new approaches – inspirational teaching, ***versus*** sticks with usual methods, attributes failure to child and doesn't reflect on own practice.	3.5, 7.1, 9.7, 10.6 1.1, 1.4, 5.6	7 7.95%
Managing behaviour in class	Having good behaviour management, ***versus*** poor discipline, chaotic classroom.	2.4, 5.7, 7.7	3 3.41%

Category	Definition	Constructs	Sum %
Teacher confidence in their philosophy & in their ability to realise it	Feeling confident and contributing to plans, ***versus*** feeling insecure and not contributing to planning; Secure in beliefs about teaching, ***versus*** confused beliefs about teaching; Flexible, willing to change in order to implement philosophy better, ***versus*** rigid, set ways of doing things.	1.2, 6.4, 10.3 1.7, 3.4, 9.1 3.3, 4.4	8 9.09%
Personality and style of delivery	Patient, jovial, receptive and calm, ***versus*** impatient, humourless, unreceptive.	3.7, 6.5, 11.4	3 3.41%
Having a range of teaching ideas and methods	Having a wide range of teaching methods, equipment and strategies, ***versus*** having just one way to teach each thing.	5.8, 7.2, 10.4, 11.6	4 4.55%
		TOTALS	88 100%

CHAPTER 5
RESULTS AND DISCUSSION OF PHASE ONE

5.1 INTRODUCTION

This chapter will describe and discuss the results which were obtained from Phase One of the main study, which explored the nature, range and perceived changes in the constructs which the staff held about the teaching of number. The discussion will address the following four Research Questions, which were originally formulated in Chapter three. (The remaining three Research questions will be addressed in Chapter 7, through discussion of Phase Two results.)

Research Question 1: *What is the range of constructs which Maths Recovery trained teaching staff have about the teaching of number?*

Research Question 2: *To what extent are these constructs shared between staff members?*

Research Question 4: *How do teaching staff perceive that their thinking about the teaching of number develops, following Maths Recovery training?*

Research Question 5: *What changes have teaching staff made in their teaching approaches and practices, after receiving Maths Recovery training? What changes are they intending to make?*

Before discussing the results obtained, some issues and observations which arose during the study will be examined. Firstly, the characteristics and selection of interviewees will be discussed, and then some issues which arose from the running of the interviews.

The data arising from the interviews will then be considered. Eleven interviews were conducted in all, and the results for each one consisted of the numerical analysis of simple differences (as described in 4.3.3.2 above) and a feedback sheet, amended after discussion with the interviewee as appropriate (as described in 4.3.3.3 above). The results from each interview will be summarised, using key extracts from the feedback sheets, and the process of feeding back will be discussed.

Next, the nature of the constructs which staff generated will be considered, by looking at the data across interviews. The range and nature of the constructs generated will be examined, thus addressing Research Question 1, and there will be a consideration of the extent to which these constructs were shared or similar, thus addressing Research Question 2.

Research Question 4 asks how the staff perceive that their thinking about numeracy teaching has developed, following the MR training. In order to explore this, the staff's understanding of what constitutes good numeracy teaching will first be examined. Following this, there will be an analysis of how staff's ratings of themselves on the overall construct, 'teaches numeracy very well' reflect changes in their thinking. This will be achieved through looking at comparisons between their ratings of the different elements, including 'me now' and 'me just before MR training'.

Finally, the data about changes which staff made to their teaching approaches and practices will be summarised and discussed, in order to address Research Question 5.

5.2 CHARACTERISTICS OF THE GROUP OF INTERVIEWEES

The eleven staff who were interviewed were volunteers from a group of twenty-eight primary school staff, who had completed their MR training. An attempt was made to balance the twenty-eight staff for gender, whether they were teachers or teaching assistants, and for how recently they had undertaken their MR training. However, no attempt was made to balance for these factors, with the eleven staff interviewed. The number of interviews was too small to permit any analysis on the basis of these factors, and the nature of the study was not such as to require that analysis. The initial attempt to balance the staff group was made in order to try to interview as disparate a group of staff as possible, and thus to sample a wide range of staff constructs.

Of the eleven staff who were interviewed, ten were female and one was male. This roughly reflects the gender ratio for the whole group of Cumbrian staff which has so far undertaken the MR training. Ten interviewees were teachers, and only one was a teaching assistant. Amongst the whole MR trained staff group, about half were teachers, and the remainder were teaching assistants. The reason for the low number of teaching assistants who were interviewed lies partly in their contractual conditions: they are hourly paid, often part-time people with family commitments, and the interviews would have had to be conducted in unpaid time. (Four staff members cited this as the reason they were not willing to be interviewed.) It may also be that the teaching assistants felt less confident to engage in the interview, although this would be difficult to verify. In terms of years of experience, the eleven interviewees had a mean of 20.9 years of experience, and a range from 12 to 35 years. There are no comparison figures available for the whole group of MR trained teachers: however, it is notable that the interviewees are all people with long experience. This tends to support the idea that only the more confident staff responded positively to the interview invitation.

5.3 ISSUES ARISING FROM RUNNING THE INTERVIEW

In running the interviews, several issues which may have affected the results arose. One such issue was around the selection of role-titles which were used to prompt the interviewees to generate the element. The interviewees were given a role-title such as 'my best teacher', and asked to name a teacher who roughly fitted the role, as one of their elements. This procedure, which had seemed unproblematic in the pilot work, did cause some difficulties. Some interviewees had difficulty in nominating elements for the negative-sounding role titles, 'a teacher I disliked' and 'colleague I disagree with'. This was coped with by reassuring the interviewees, firstly that their choice of name was totally confidential, and secondly that it did not matter if the named person was only mildly like the role-title.

The importance of the role-titles to the study was two-fold. Firstly, it enabled comparisons between ratings on the role-titles involving 'me', in order to see whether there had been any shift in their constructs about themselves. (This will be discussed below, in 5.7, p148.) Secondly, by having a spread of positive and negative roles, it was hoped that it would enable them to express a wide range of different constructs about teaching and learning, instead of a narrower focus on ideas about good teaching. To some extent, this was successful: where interviewees were asked, in the triadic elicitation procedure, to use negative elements to generate the emergent pole of a construct, they were generally able to do so. Examples of this include:

- Construct 4.4 (generated from elements 8 & 5, versus 3) Rigid, inflexible – set ways of doing things. (Contrast pole was: Relaxed approach, flexible)
- Construct 5.5 (generated from elements 8 & 5, versus 7) Keeps repeating things if child doesn't understand. (Contrast pole was: Goes back to earlier stage, to find out what the problem is)
- Construct 7.3 (generated from elements 8 & 5, versus 2) Teaches topics as an entity: doesn't think of breaking things down. (Contrast pole was: Breaks work down to make it easy for children to learn).

However, there was a difficulty which emerged when the interviewees rated the elements on the constructs. Because the role titles used judgmental language, some interviewees tended to be quite polarised in their thinking when they were rating the elements. Thus, an element which had been generated from a negative role-title would tend to get negative ratings on all the constructs – almost as though the interviewee had decided that, if that person was an example of 'a teacher I disliked' then they must be placed on the undesirable end of every construct. For example, Interviewee number 2 shows such a pattern, using the extreme ratings (1 and 5) very much, and tending to give the same rating to an element on each of the constructs. She seemed, quite early in the interview, to have adopted a 'Constellatory' way of thinking (Bannister & Fransella, 1980, p29), which led to stereotypical thinking and prevented her from seeing positive attributes in the elements which she had generated from the negative role titles. She found it very hard to work with the negative elements and the element cards, and the way she had used the ratings appeared to be closing down her thinking: it was necessary to use Laddering Down and some open-ended discussion, after which she became more able to articulate her constructs.

It seems that the use of negative role titles served to inhibit or narrow the thinking, for some interviewees. In any future studies, it would be helpful to avoid the use of negative role titles, but instead just to ask the interviewees to use as wide a range of staff as they can, in terms of what the staff were like and how they felt about them.

Other issues arising during the interviews were to do with the interviewees' experiences of the interview process: how easy they found the task, how much they felt it enabled them to express their views, and how they engaged with the opportunity for follow-up discussion with the interviewer. For each of the eleven interviewees, it was possible to generate eight distinct, relevant constructs, but some found the process much more difficult than did others. Triadic elicitation was the starting point in all interviews, but all but one of them also used laddering, and in most of them it was necessary to use other techniques as well. Table 5.1 below summarises the elicitation techniques used, and gives a qualitative comment about each interviewee's experience. (This is derived from interviewer observations, plus any comments made by interviewees.) The right hand column of the table shows whether the interviewees contacted the interviewer after the feedback sheet was sent to them, and indicates the nature of any discussion which ensued. The table suggests that there is a wide variety in the techniques which people find helpful, when generating constructs, but that the techniques used were adequate for the purpose. (The 'Other' column refers to instances where constructs were generated through general discussion, or where people spontaneously referred back to previous parts of the interview, in order to generate new constructs.) It also suggests that the interviewer's analysis of the interview information was felt by just over half of the interviewees to be quite accurate: although with such a small number of interviewees and with several of them not responding, this should be treated with caution.

<table>
<tr><th>Inter-viewee no.</th><th>Triad</th><th>Laddering</th><th>Pyramiding</th><th>Character sketch</th><th>Other</th><th>Interviewee response to feedback sheet</th></tr>
<tr><td rowspan="2">1</td><td>✓</td><td>✓</td><td></td><td></td><td>✓</td><td rowspan="2">Accepts as accurate.
Adds new construct.</td></tr>
<tr><td colspan="5">Triads and pairs used: found process quite easy but absorbing.</td></tr>
<tr><td rowspan="2">2</td><td>✓</td><td>✓</td><td></td><td></td><td>✓</td><td rowspan="2">Accepts as accurate.</td></tr>
<tr><td colspan="5">Found triadic elicitation hard, especially with negative elements.</td></tr>
<tr><td rowspan="2">3</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td rowspan="2">Accepts as accurate.</td></tr>
<tr><td colspan="5">Found triads helpful, and interview flowed well.</td></tr>
<tr><td rowspan="2">4</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td rowspan="2">No response.</td></tr>
<tr><td colspan="5">Found triadic elicitation hard. Formed global constructs, laddering down used to analyse these further.</td></tr>
<tr><td rowspan="2">5</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td rowspan="2">No response.</td></tr>
<tr><td colspan="5">Used triads easily, and spontaneously began to ladder downwards.</td></tr>
<tr><td rowspan="2">6</td><td>✓</td><td>✓</td><td>✓</td><td></td><td>✓</td><td rowspan="2">No response.</td></tr>
<tr><td colspan="5">Found triads hard: used pairs and pyramiding. Strong emotional content, relating feelings to beliefs about teaching.</td></tr>
<tr><td rowspan="2">7</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td rowspan="2">Accepts as accurate.
Says is helpful.</td></tr>
<tr><td colspan="5">Triads gave global construct, laddering & pyramiding used to unpack. Took time to reflect & articulate ideas.</td></tr>
<tr><td rowspan="2">8</td><td>✓</td><td>✓</td><td></td><td>✓</td><td>✓</td><td rowspan="2">Accepts, with some editing.</td></tr>
<tr><td colspan="5">Founds triads hard, especially with negative elements. Constructs flowed from character sketch & discussion.</td></tr>
<tr><td rowspan="2">9</td><td>✓</td><td>✓</td><td></td><td></td><td></td><td rowspan="2">No response.</td></tr>
<tr><td colspan="5">Formed global constructs, and found hard to unpack. Found negative elements hard to work with.</td></tr>
<tr><td rowspan="2">10</td><td>✓</td><td></td><td></td><td></td><td>✓</td><td rowspan="2">Accepts as accurate.</td></tr>
<tr><td colspan="5">Found triads hard to use: used pairs plus open-ended discussion.</td></tr>
<tr><td rowspan="2">11</td><td>✓</td><td>✓</td><td>✓</td><td></td><td></td><td rowspan="2">No response.</td></tr>
<tr><td colspan="5">Found triads helpful: generated several constructs from each, and spontaneously used laddering down.</td></tr>
</table>

TABLE 5.1: Summary of Responses to Interview and to Feedback Sheets

5.4 FEEDING BACK RESULTS TO THE INTERVIEWEES

As can be seen from table 5.1 above, six of the eleven interviewees responded to receiving the feedback sheet after the interview, and two of these suggested changes or additions to it. The responses were either in the form of an email, or of a telephone conversation. They were generally positive, saying that the feedback sheet captured the main points from the interview, and was an accurate summary of the interviewees' views. Where interviewees disagreed with the sheet, the sheet was edited to reflect their views.

The completed sheets for all interviewees are given in Appendix G (p266). The format for each sheet was in three sections. The first section listed the constructs which the interviewee had generated, and showed the 'simple differences' matrices for 'Similarities Between Constructs' and 'Similarities Between Elements'. The next section interpreted the data from the first section in narrative form, including a key paragraph on the interviewee's concept of good numeracy teaching, and a key paragraph on their view of themselves as teachers and how they have changed over time. The final section listed the changes which the interviewees said they had made, or intended to make, following the Maths Recovery training. The two key paragraphs from each interviewee are given below, in Table 5.2, and are discussed in 5.6 below.

TABLE 5.2 Key Paragraphs from Interviewee Feedback Sheets

Interviewee	*Good Numeracy Teaching (Derived from Similarities between Constructs)*	*Me as a Numeracy Teacher, and How I Have Changed (Derived from similarities Between Elements)*
1	*Constructs 1,2,3,4,5 & 9 are closely related, and correlate with the donated construct, 'teaches numeracy very well' (9). A picture emerges of the good teacher of numeracy, who works hard (3) and with confidence (2), seeking to inspire (4) pupils and to motivate them to develop their own learning (5). This teacher is willing to take risks (1), in order to develop such inspirational teaching (4). Constructs 6 & 7 are also closely related, i.e. having good subject knowledge goes with having a secure belief in one's philosophy of teaching.*	*The interviewee perceives herself as very similar indeed to her 'best teacher' (6), and also similar to 'professionally respected colleague' (7), and feels that she is now more like this respected colleague than she was as a new teacher.* *The grid suggests that her views did not change much as a consequence of undergoing Maths Recovery training. ('Me just before training' (2) and 'me now' (3) receive almost identical ratings.) However, discussion with the interviewee reveals more. She talks about a new construct:* Breaks work down and goes back to first principles ⟷ Tries to plug the gaps in pupils' knowledge *She says this is an important construct for her, and that she has moved further towards the left hand (positive) pole of it, as a consequence of the training and of her subsequent work with Maths Recovery.*
2	*A picture emerges of a good numeracy teacher, who is very committed, knows how children learn, and uses this knowledge to individualise work tasks, so that each child will learn effectively. The grid also shows that 'committed to the job (1)' is closely related to 'enjoys the job (2)', and that*	*The interviewee rates herself now (3) as very similar to 'the best teacher I could be (4)', and close to 'my best teacher (6)' and to 'professionally respected colleague (7)'. She explains this by saying that, because she has vast experience and much training, she must by now be approaching the best she can ever be. In*

	'structures their teaching (5)' is closely related to 'provides work to stretch each child (7)'. *Looking at the relationships between reversed constructs, we see that construct 4, 'good behaviour management', is also related to 'teaches numeracy very well (9)'. The interviewee sees 'poor behaviour management' as being unlikely to accompany 'good numeracy teaching (9)' or 'commitment to the job (1)', or 'knowing how children learn number (3)'.* *When the interviewee was asked to say which of her constructs were most important for good teaching, and which were less central, she was unable to do this: for her, they all interact to make an essential contribution to the good teaching of number.*	*contrast, she rates 'me when new to teaching (1)' quite negatively, and perceives it as very different from 'me now (3)' and 'the best teacher I could be (4)'.*
3	***This gives a picture of the good numeracy teacher as a dedicated person, who empathises with the child. Rather than telling children what to do, this teacher sets tasks and patiently gives children opportunities to solve them. This teacher wants children to be self-motivated through enjoying the work. She is reflective about her teaching, and changes her practice accordingly.***	***It seems that the interviewee has always, right from the start of her teaching career, been dedicated, reflective and willing to change. She thinks that before Maths Recovery training, she was similar to 'respected colleague'(7) and 'my best teacher' (6). (Perhaps she had modelled aspects of her teaching on theirs?) After the training, she feels she has moved closer to her ideal ('the best teacher I could be'), having gained confidence to be less directive and more a facilitator of children's problem-solving.***
4	***The picture of a good numeracy teacher which emerges is of one who values all pupils for what they are, and therefore aims the teaching at where each individual pupil***	***The interviewee has a positive view of herself as a numeracy teacher, both before and after Maths Recovery training. She feels that she has improved somewhat since the MR training, in***

	currently is. She does this through clearly structured lessons, with much interaction with the pupils. She has good understanding of how to teach number, and also good knowledge of number. She wants the children to become self-motivated, through their enjoyment of the subject. She takes a flexible and relaxed approach, avoiding 'chalk & talk' and attempting to empathise with pupils.	*that she is better at starting from where children are (2), understanding the teaching of number (6), structuring lessons(3) and being flexible (4). She perceives more change in herself, with respect to the constructs she has identified, in the two years since her Maths Recovery training than in the 16 years since she began teaching.*
5	*For this interviewee, pupil enjoyment through success is central to good numeracy teaching. Pupil success will be achieved by the teacher using her knowledge of how children learn, to differentiate work so that all children can participate. Concrete apparatus will be used where appropriate. Good behaviour management plays a role, in creating an orderly room where pupils can work well. If a pupil is not successful, this will be because the teacher has not been working at the right level, and the teacher needs to go back to an earlier stage and analyse where the pupil's difficulty lies.*	*This teacher feels that she has changed a lot in the 12 years since she began teaching, and is now not only teaching numeracy very well, but is very similar to 'the best teacher I could be'. Considerable change has happened in the two years since her MR training: she reports change on all constructs except number 7 (good behaviour management). The greatest change happened on construct 5: when children do not understand, she now goes back to an earlier stage to find out what the problem is, rather than repeating previous approaches.*
6	*For this interviewee, a good numeracy teacher is one who understands progression in children's mathematical learning, and has a desire for children to be confident and to develop their understanding, rather than just get through the work. Such a teacher has time for children, and an approachable manner, and is well-informed about what each child can do. He is teaching to fit what each child can do, rather than just following set schemes.*	*The interviewee has a positive image of himself as a teacher, seeing himself as being like those elements he respects, and unlike those he regards negatively. Comparing 'me now'(3) with 'me just before MR training'(2), it is apparent that the interviewee feels he has improved (ie become more like 'the best teacher I could be') since MR training, on all constructs except 5 ('approachable, has time for children'). Discussion showed that this teacher has recently been through some very negative*

		professional experiences, and feels that the Mathematics Recovery training has played a strong role in restoring his confidence in himself as an effective teacher, as well as giving him some new skills.
7	*For this interviewee, good numeracy teachers are those who constantly improve their teaching skills through experience. To achieve this, they try out different methods to find ones which work, and they base their methods on breaking the work down into tasks which are easy enough for the children to do. These teachers are enthusiastic about teaching maths, and they see the pupils as able to succeed. They have empathy for pupils' feelings and difficulties. They are also able to maintain discipline in the classroom.*	*This teacher has a positive view of herself as a teacher of numeracy, believing that, after 27 years experience, she is quite close to being as good as she can be. She believes she could still improve her classroom discipline (perhaps because she is out of practice at handling whole classes, as she currently works mainly with individual pupils), and that she could be even more enthusiastic about numeracy than she currently is. Despite her long experience, she feels she has shown improvements since her Maths Recovery training, and that these improvements are in the three most important aspects of the teaching: learning through experience(1), evolving new methods(2) and breaking tasks down for children(3). She says that, although she has always had empathy for children's' difficulties, she now knows more about what to do in order to help them.*
8	*For this interviewee, good teachers are driven by aims and intentions: they want children to enjoy succeeding, they aim to understand individual children's thinking and they have high expectations for children. It is the understanding of the children's thinking which enables these teachers to develop knowledge about mathematical development, and this in turn enables them to develop their methods of teaching. The methods which characterise*	*This teacher has a very positive view of herself as a teacher of numeracy, and also believes that she has made recent improvements. She says she is better than she was just before the MR training, as she has more knowledge of mathematical development, and is more knowledgeable about detailed assessment. She says that she thinks she could improve still further, by extending her knowledge of children's mathematical development through getting more experience in using MR*

	good maths teaching include detailed assessments of what each child can do, use of questions to prompt children to analyse their own thinking, matching teaching to where the child is, and empowering them to be confident and independent.	***teaching. She says, "I always felt I had a 'blank wall' when it came to understanding what children were doing – that's what MR gave me. It took me to the place that I knew was there."***
9	***For this teacher, there are two main aspects of good numeracy teaching. The first relates to knowledge and understanding, both of the number system (construct 4) and of how children learn (construct 2), and to the application of this knowledge in the design of assessment and teaching (construct 3). A good teacher is well informed, and uses this knowledge in planning. The second aspect relates to motivation and enjoyment: a good teacher wants to help children improve (construct 6), enjoys working with them (5) and is keen to improve as a teacher (7). Teachers who are good at both of these aspects are seen as being able to respond to the learning needs of all pupils, rather than just to those of the more able.***	***This teacher feels that her numeracy teaching changed little in the 29 years since her initial training, but has improved considerably in the two terms since she started the MR training. She feels she is now very close to being as good a teacher of numeracy as she could be, although she also says she is still keen to improve (construct 7)! She rates 'me now' identically to the ratings she gives to 'professionally respected colleague', on the constructs which she generated: possibly, this colleague is serving as a model for excellent teaching.***
10	***For this interviewee, a good numeracy teacher is open to new ideas about teaching, and uses a wide range of teaching methods. There is an aim for children to be motivated to develop their own understanding, and this leads the teacher to let children choose what to do, and to be sensitive to the child's existing level of understanding, offering activities which match this rather than focussing on covering lots of curriculum material. A good teacher***	***This interviewee, who is a teaching assistant, sees herself as now close to the best she could be, and feels that she has improved as much in the two terms since starting the training, as she did in the previous ten years of work as a teaching assistant. She now sees herself as similar to 'professionally respected colleague', and she speaks of having become confident to share planning effectively with a teacher, knowing that they have a common view of how to support the children's learning.***

	understands mathematical ideas well, and is therefore confident both to plan activities for children, and to adapt these as necessary, in response to what pupils do.	
11	***For this interviewee, underlying knowledge and understanding (both of learning and of teaching) is the key to good numeracy teaching. Thorough planning and good organisation are also important. If these aspects are in place, other facets of good numeracy teaching are likely to develop. A good numeracy teacher listens to the child in a relaxed way. Lessons are fun and interesting, and this is achieved through being flexible around plans in response to pupils' needs, as well as having a wide range of teaching methods available from which to choose.***	***This interviewee feels that her numeracy teaching did not improve significantly between starting as a teacher and just before MR training. However, it has improved considerably, since starting the MR training. She has made most change in her knowledge of how children learn (construct 2) and her understanding of a range of ways to teach things (construct 6). She made no change on construct 4, as she has always been 'receptive, relaxed and calm', believing it is important to give children opportunities to respond. The interviewee believes that, although she has improved a lot, she can still get better. Further improvement could still happen on constructs 5, 7 and 8: this would involve the flexible use of planning and organisation to support differentiation, so that each pupil experiences a purposeful, engaging lesson, which they find fun. Discussion showed that confidence has been an issue for this interviewee, who says that she herself struggled with numeracy, when she was a pupil. She comments that she was surprised and pleased at the really good progress made by the pupil whom she taught during her MR training: "I hadn't thought that (pupil name) could come on that much."*** *(Note: as the interviewee only finished the MR training a few weeks before the interview, she may still be in a relatively early stage of consolidating the application of the MR training in her work.)*

Notes:	• The paragraphs for Interviewees 1 & 2 are less compact and well-targeted than the others, because the format for the feedback sheets was still evolving. Hence, these two interviewees' information is given in plain type, where the others are in bold italic. • Construct numbers are given in brackets, as single numerals. E.g. for interviewee 11, the construct referred to in this table as construct 2 is in fact construct 11.2, which can be accessed by referring to interviewee 11's feedback sheet in Appendix G(11).

5.5 STAFF CONTRUCTS ABOUT THE TEACHING OF NUMBER

This section will address research Question 1, concerning the range of constructs which the staff generated, and Research question 2, about the extent to which these constructs were shared.

5.5.1 The Range of Constructs

Each interviewee was able to generate eight distinct constructs, and most of the interviewees generated a range of types of construct. Across all interviewees, a wide range of types of construct was produced. (A list of all 88 constructs which were generated by the 11 interviewees is given in Appendix J (p310.) Using Jancowicz's (2004) categories for types of construct as a framework, some examples are given and discussed below:

- ***Core versus Peripheral constructs:*** to a very great extent, the interviewees said that they found it difficult or impossible to rank order their constructs in terms of how they contributed to good teaching. They saw their constructs as "all interwoven" (interviewee 2) or "all really important" (interviewee 4). Because of these comments, no attempt has been made to analyse the rank orders which some interviewees interviewees did produce, as they would be likely to be of low validity.
- ***Propositional versus Constellatory constructs:*** There were no constructs which could be considered 'propositional', i.e. too superficial or situation-specific to show a relationship to the other constructs. Where such constructs were initially generated, a technique such as laddering upwards was used to arrive at a construct with more general applicability, and the

interviewee subsequently avoided propositional constructs. There was some evidence of 'constellatory' constructs. For example, interviewee number 3 generated several constructs from each other: these were closely related, with elements tending to be seen as positive (or negative) in all contexts, rather than as having good and bad aspects. Such 'constellatory' thinking was generally unhelpful, because it tended to narrow the range of ideas which were explored, and the interviewee would sometimes get stuck on elaborating just one construct. This often started to happen when interviewees found it hard to work with the negative elements: e.g. interviewee 8, who got quite stuck, until the character sketch approach (described in 4.3.2.5 above, p89) was used to unblock the thinking.

- ***Pre-emptive constructs:*** these are constructs which so predetermine or dominate the others, that the others become redundant. None of the interviewees used any constructs in this pre-emptive manner.
- ***Affective constructs:*** these occurred in two main ways: most commonly, interviewees (numbers 4, 5, 2, 8, 3, 10 & 11) referred to wanting their pupils to have positive feelings. Less commonly, interviewees (numbers 7,2,1,9) generated constructs about their own enjoyment or feelings of confidence or insecurity about teaching.

- ***Behavioural constructs:*** many of the constructs related to teacher behaviour, e.g. in terms of how tasks are presented (construct 3.8), how teachers interact with pupils or use questions (constructs 4.7, 8.6), how they differentiate (2.7, 5.2, 8.7, 9.3), how they vary their teaching (5.8, 7.2, 10.4, 11.6). there was also a group of constructs about pupil behaviour, and teachers' intentions and stratetgies to manage it (2.4, 5.7,7.7).
- ***Evaluative constructs:*** these constructs, which imply an opinion or judgment, were common. They related mainly to staff valuing working with children (1.3, 9.6), believing in the importance of numeracy work (6.3, 2.1), or having respect and empathy for pupils (8.5, 3.1, 4.1, 7.6).
- ***Attributional constructs:*** these, which involve perceived reasons for behaviour, were very common. Some related to staff seeking to motivate pupils through fun or success (5.1, 8.4, 3.2, 7.7, 8.8, 10.2). Others related to staff's own motivation (9.6, 4.8, 2.1, 3.6).

It can thus be seen that, using the PCP grid interview procedures, staff were able to generate a wide range of constructs about the teaching of number. Some staff required more support than others, in order to generate usefully independent constructs, but the interviewee and interviewer were always able to agree a form of words which expressed the construct to the interviewee's satisfaction.

5.5.2 Extent to which the Constructs are Shared

The absence of major difficulties in finding agreed words to express the concepts, during the interviews, was an encouraging sign for the possibility of interviewees, or of other staff, sharing the constructs. When the author examined the 88 constructs which had been generated, many of them did seem to cluster into groups containing the same or similar constructs. However, this kind of 'eyeball analysis' was not sufficient to establish the position. Some evidence for this could come from doing a more formal content analysis of the data, and establishing its reliability. This was in fact carried out, using Honey's Content analysis, as described above in Chapter 4 (4.3.4 p105). Through this analysis, the 88 constructs were fitted into 15 categories, suggesting that some of the original constructs were shared or similar. The Reliability Index (Using Jancowicz's procedure, as described in 4.3.4 above, p 108) which was obtained for this final category system was 95.2%, which is a reassuringly high value.

A second source of evidence could come from attempts to use the interviewees' constructs with other teaching staff. If these staff find that the constructs make sense to them, and that they can use them to reflect on their own development, then this would be evidence that the constructs are to some extent shared. This was done, in Phase two of the study. The 88 constructs were used as the basis for items in a questionnaire, as will be described in chapter 6 below. The meaningfulness and ease of use of this questionnaire by staff other than the original interviewees was then piloted. Chapters 6 and 7 will discuss the results of this.

5.6 THE DEVELOPMENT OF STAFF CONSTRUCTIONS ABOUT THE TEACHING OF NUMBER

This section will address Research Question 4, by looking at how staff perceived their thinking about numeracy teaching to have developed, following their MR training. Firstly, there will be analysis of the staff constructs about good numeracy teaching. This will enable, in the following section, an analysis of how staff see themselves to have changed following the training, and of how closely they now think they approach their own concept of 'the best teacher I could be'.

5.6.1 Staff Constructions of Good Numeracy Teaching

For each interviewee, their view on what good numeracy teaching is like could be inferred, from looking at the relationships between the donated construct 9, 'teaches numeracy very well' and the other constructs which they had generated. Where a construct was used to rate elements very similarly to the way construct 9 was used, it was inferred that it was probably being seen as a facet of good numeracy teaching. The pattern of similarities and differences between constructs, given in the 'Similarities between Constructs' matrix for each interviewee, was used to draft a brief description of how that interviewee construes good numeracy teaching. After these descriptions had been fed back to the interviewees and altered in the light of any responses, they were taken to be valid descriptions. The descriptions are given, for each interviewee, in column 2 of Table 5.2

above. Whilst it was not an aim of this research to reach an agreed description of good numeracy teaching, it was noted that the descriptions do seem very similar. Some features which are common to most of these descriptions are:

- A pupil-focused motivation, wanting them to succeed and to enjoy learning
- Valuing and empathising with pupils
- Understanding how children learn, and using this to plan the teaching
- Knowing what each individual pupil can do, and offering experiences to fit this
- Having good underlying mathematical knowledge

These features seem to be in tune with the principles of Mathematics Recovery, as expressed through its nine principles (appendix K p314). However, there are some aspects of the nine principles which seem to be missing or infrequent in the staff descriptions of good numeracy teaching. These include:

- The enquiry-based nature of MR teaching, as embodied in Principle 1. However, Interviewee 3 does mention that good teachers set tasks and patiently give children opportunities to solve them.
- Ongoing assessment, so as continually to revise one's understanding of the child's current strategies and understanding (Principle 2). However, interviewee 8

does talk about understanding children's thinking, through detailed assessments of what each child can do.

- Focusing just beyond the 'cutting edge' of the child's knowledge (Principle 3). Interviews 4, 5, 6, 8 all mention differentiating and matching tasks to children as being characteristics of good teaching. However, no-one talks explicitly about the 'cutting edge' or the Zone of Proximal Development.
- Using understanding of children's numerical strategies to foster the development of more sophisticated ones (Principle 5). Interviewee 6 talks about understanding progression in children's mathematical learning, but no-one explicitly mentions the idea of engendering more sophisticated strategies.
- Continual micro-adjusting by the teacher, on the basis of intensive, ongoing observations (Principle 6). The idea of a continuous cycle of observation and micro-adjustment, until the pupil succeeds, is not nominated as a feature of good numeracy teaching by any of the interviewees.
- Building on intuitive, verbally-based strategies, and using these as a basis for written forms (Principle 7). This is not nominated as a feature of good numeracy teaching by any of the interviewees.

- Providing the child with sufficient time for sustained thinking and reflection on the results of his own thinking (Principle 8). The concepts of sustained thinking and of child reflection are not explicitly mentioned, in any of the staff descriptions of good numeracy teaching.
- Children gaining intrinsic satisfaction from problem-solving (Principle 9). This is not mentioned by staff as a facet of good numeracy teaching. Interviewees 5, 8 and 11 mention enjoyment through success and through fun, but not specifically through the problem-solving itself.

This lack of explicit citing by the interviewees of many of the MR principles when they describe good numeracy teaching might initially seem rather strange and disappointing. However, it must be borne in mind that the 'good numeracy teaching' paragraphs are only summaries, derived from hypotheses about the relationships between the constructs which the staff generated. In order to explore this further, it would be necessary to go back to the level of the 88 individual constructs which were generated by the staff, and to do a more detailed analysis of these relative to the nine principles of MR. This would reveal more about the constructs which the interviewees had about numeracy teaching, and about how closely their constructs mirror those of the MR principles. Such an analysis has been undertaken, and is given in Chapter 7, section 7.2.

5.6.2 Staff Perceptions of their Development Following MR Training

Because the element role titles used in the grids included three self-elements - 'me when new to teaching', 'me just before MR training' and 'me now' - it was possible, by comparing the ratings of these elements on construct 9, to get an impression of how each interviewee felt that their numeracy teaching had changed and developed, over time. Firstly, this was done in a purely qualitative way, by using the 'Similarities between Elements' matrix for each interviewee to write a hypothetical description of how they felt they had developed. In a procedure analogous to that used in 5.6.1 above for the 'similarities between Constructs' matrix, the resulting descriptions were validated by sending them to the interviewees and using their feedback to adjust them. The result was the descriptions of the interviewees' development as numeracy teachers, which are given in column 3 of table 5.2 above.

It would not be meaningful to attempt to summarise common points from these descriptions, as each one is a personal narrative, with an internal coherence. In writing them, data was drawn not only from the 'Similarities between Elements' matrix, but also from the notes which the interviewer took during the interview, which often included explanatory comments about the meaning or salience of constructs. However, one striking aspect of these descriptions is that they all rate themselves positively on the construct of 'teaches numeracy very well', and that they feel the MR training helped to move them in that direction.

An attempt was made to capture this positive judgement in numerical terms, using the interviewees' ratings of themselves on Construct 9, at the three points in their teaching career which are represented by the three self-elements, and their ratings on construct 4, 'the best teacher I could be'. This is given in Table 5.3 below:

1	2	3	4	5	6	7	8 (4-5)	9 (5-6)	10 (6-7)	11 (5-7)
Interviewee No.	**Years in teaching**	**Years since end of MR training**	**Element 1: Me when new to teaching**	**Element 2: Me just before MR**	**Element 3: Me now**	**Element 4: The best teacher I could be**	**Improvement up to MR training**	**Improvement since MR training**	**Distance of 'me now' from element 4**	**Distance of 'me before MR' from element 4**
1	20	3	*3*	*2*	*2*	*1*	1	0	1	1
2	35	2.5	*4*	*2*	*1*	*1*	2	1	0	1
3	23	2	*4*	*3*	*1*	*1*	1	2	0	2
4	16	1.5	*3*	*3*	*2*	*2*	0	1	0	1
5	12	2	*4*	*3*	*1*	*1*	1	2	0	2
6	20	2	*3*	*2*	*1*	*1*	1	1	0	1
7	27	2.5	*3*	*3*	*2*	*1*	0	1	1	2
8	24	1.75	*4*	*2*	*1*	*1*	2	1	0	1
9	15	2	*3*	*3*	*1*	*1*	0	2	0	2
10	11	1	*4*	*3*	*2*	*1*	1	1	1	2
11	5	0.25	*4*	*4*	*2*	*1*	0	2	1	3
	Total 208 Mean 18.9	Total 20.5 Mean 1.9					Total 9 Mean 0.82	Total 14 Mean 1.27	Total 4 Mean 0.36	Total 18 Mean 1.64

Table 5.3: Interviewees' self-ratings on 'teaches numeracy very well' at different points in their careers

Column 8 of the table compares the interviewees' ratings of themselves when new to teaching with those of themselves just before their MR training. This gives an idea of how much they think they have improved, across their teaching career before the MR training. Column 9 of the table compares their ratings of themselves currently, with themselves just before MR training. This gives an impression of how much they think they have improved since starting the MR training. Inspecting the raw data in these two columns suggests that they feel they have improved more since the MR training than they did up to the start of the training – even though (as shown in columns 2 and 3) they had much more experience before the MR training than since the training. To test this hypothesis, a non-parametric test was needed, as the ratings cannot be regarded as constituting an interval scale. The Fisher Exact Probability test, as described in Siegel (1956) was therefore used, to compare the teaching staff's self-ratings of their improvements before and after MR training.

	Perceived improvement in ratings: 2 0r more rating points	Less than 2 rating points	
Before MR training	2	9	11
After MR training	4	7	11
	6	16	N=22

Table 5.4: Contingency table summarising staff self-ratings before and after MR training

Applying the Fisher Exact Probability test to the data in the above table shows the results to be significant at the 0.05 level (Siegel, 1956, table I p259). This shows that there is indeed a real difference in the self-ratings of staff improvement before and after the training.

Returning to Table 5.3 above, column 10 compares staff ratings of themselves now with those of 'the best teacher I could be', and therefore gives an estimate of how close they feel they are to their conception of the ideal numeracy teacher. Again, Fisher's Exact Probability Test was used to compare their perceived distance from the ideal after MR training with that before the training.

	Perceived Distance from 'the best I could be': 2 or more rating points	Less than 2 rating points	
Before MR training	6	5	11
After MR training	0	11	11
	7	15	N=22

Table 5.5: Contingency table summarising staff perceptions of their distance from 'the best teacher I could be', before and after MR training

Applying the Fisher Exact Probability test to the data in the above table shows the results to be significant at the 0.005 level (Siegel, 1956, table I p259). This shows that there is indeed a real difference in the self-ratings of closeness to their ideal, before and after the training.

Visual inspection of the table 5.3, together with the statistical confirmation of the significance of the results, serves to support some of the hypotheses which the author formed whilst conducting interviews and analysing the individual grids. The data supports the view that:

- Staff had made a modest improvement in the years between starting teaching and doing MR training, with a Mean of 0.82 of a rating point. The staff had a lot of experience, with a mean of

18.9 years experience. This suggests a slow rate of improvement, overall.

- Staff did make greater improvement in the time between MR training and the interviews, with a Mean of 1.27 of a rating point. This was a significantly greater improvement than that made before the MR training. Moreover, this occurred over a much shorter period of time, i.e. a mean of 1.9 years. Staff had used the ratings to say that they improved much more quickly after the MR training than they did in their previous years in teaching.
- Staff, at the time of the interview, rated themselves as quite close to being as good a teacher of numeracy as they could be. Seven of them gave themselves the same rating as they gave to 'the best teacher I could be' on contruct 9, 'teaches numeracy very well'. The remaining four staff had only one point of difference in their scores. Staff perceived themselves as closer to 'the best teacher I could be' after the training than before it, as is confirmed by the Fisher test above (Table 5.5). The staff, having had an opportunity to do the MR training, practise using it (for an average of 1.9 years) and reflect upon it via the interview process, had become very confident in themselves as teachers of numeracy.

This very positive picture of staff perceptions of their improvements which emerges through looking at the ratings is reinforced by comments which staff made during the interviews. Some examples illustrate this:

> "I hugely benefited from doing this course: it was confusing at first, but then it came together and all made sense.." (Interviewee 10, teaching assistant with 11 years experience.)

> "I've got more ideas up my sleeve now, and the confidence to do it......I can adapt it to different situations now." (Interviewee 9, teacher with 15 years experience.)

> " the training hasn't changed what I want for children or how I feel about them......but it's given me the knowledge ....the skills and tools...so that I can help them more." (Interviewee 4, teacher with 16 years experience.)

5.7 CHANGES IN TEACHING APPROACHES FOLLOWING MATHS RECOVERY TRAINING

Research Question 5 asks about the changes in their teaching approaches and practices, which staff have made or intended to make, following their MR training. For each interviewee, these changes were listed in the final section of their interview feedback sheet, and these sheets are in Appendix G. To aid interpretation, these changes have been summarised in Table 5.6 below, by grouping similar ones together, in a procedure similar to Step 2 of the content analysis used for the constructs, as described in Chapter 4 (4.3.4, page 106).

Table 5.6 below summarises the changes which staff described.

TABLE 5.6: Changes in Teaching Approaches Following MR Training

Category Description	No. of items in category		Item Description (Interviewee no.)	Actual (A) or Intended (I)
	Actual (A)	Intended (I)		
Assessing groups of pupils with MR tools: using MR materials to group for teaching and to plan the teaching	4	5	Use assessments & teaching activities for short-term small group work (8).	I
			Use assessments with groups, and use results to plan teaching (11)	I
			Use assessments to group for teaching (4)	A
			Group children by SEAL stage, use MR teaching activities with groups (4)	A
			Use MR assessments on all Key Stage 1 pupils, and group them accordingly for numeracy teaching (4)	I
			Assess all Year 1 pupils and use results to group for small group teaching (5)	A
			Assess all pupils in a year group, and use results to form & teach small groups (10)	I
			Use MR activities in small group work (5)	A
			Use MR activities in small group withdrawal work (2)	I
Delivering or supporting individual MR programmes to pupils, or improving the quality of existing individual teching arrangements	4	4	Use MR tools & activities in Individual Education Plans (2)	I
			Have a better structure to existing individual maths programmes (7)	A
			Give individual MR programmes to all pupils with learning difficulties (7)	A
			Recommend individual MR programmes for pupils, and advise teachers about resources and content (4)	A
			Run individual MR programmes for pupils with difficulties (5)	A
			Run individual MR programmes with children (9)	I
			Deliver MR programmes to individual pupils (10)	I
			Deliver more individual MR programmes (11)	I

Category Description	No. of items in category		Item Description (Interviewee No.)	Actual (A) Or Intended (I)
	Actual (A)	Intended (I)		
Constructivist orientation: emphasis on children exploring and developing their understanding	4	0	Lead children towards developing understanding, rather than teach them mathematical methods (6) Place greater emphasis on children exploring their methods of solving problems (4) Go back to first principles/early stages when working with children – don't just 'plug the gaps' (1) Help children to build on what they already know, rather than transmit knowledge didactically (3)	A A A A
Developing the use of particular types of activity, in their teaching generally	4	0	Adapt MR activities to include more written responses, so as to generalise into the classroom (7) Use more oral and visual work rather than pencil and paper, in Early Years groups (2) Make greater use of spatial tasks and visual cues (5) Make richer use of counting activities, with more emphasis on backwards counting (2)	A A A A
Sharing what has been learned from Maths Recovery with colleagues	3	1	Support and advise colleagues about teaching number (4) Tell other staff how MR training will help their class teaching (4) Share insights with other staff in school (2) Find ways of supporting staff in schools to use MR at whole-school level (1)	A A A I

Category Description	No. of items in category		Item Description (Interviewee No.)	Actual (A) Or Intended (I)
	Actual (A)	Intended (I)		
Observing children more closely	4	0	Wait and observe children – don't rush in too quickly to help them (8) Watch children closely to observe where they are, rather than make assumptions (8) Observe children to find out where there are gaps in their understanding (10) Make close observations of what pupils do, and select activities to develop their understanding (11)	A A A A
Using Maths Recovery activities in whole class teaching	4	0	Integrate MR approaches into classroom teaching (9) Adapt MR activities to use with groups and classes: especially 'mental & oral starter' part of lesson (9) Use MR techniques in whole class lessons – especially 'mental & oral starter' part of lesson (4) Use wider range of activities and equipment in whole class work (2)	A A A A
Better differentiation to meet each pupil's need	5	0	Try to match how tasks are presented to each pupil's learning style (8) Observe which stage pupils are at, and match activities to this (4) Better differentiation: in class, group and individual work (2) Use MR structure to analyse next step for pupil (2) Make more use of ongoing assessment, in planning my teaching (3)	A A A A A
Changed style of verbal interaction with pupils	3	0	Discuss with pupils how they have solved or might try to solve problems (11) Ask pupils what they see: don't tell them what you want them to see (2) Change style of questioning: more open, make better use of pupil responses (2)	A A A

Category Description	No. of items in category		Item Description (Interviewee No.)	Actual (A) Or Intended (I)
	Actual (A)	Intended (I)		
Use of MR assessments as progress monitoring and tracking tool	2	1	Use MR assessments in school process for Special Needs support (8) Assess all Y2 pupils at start of year, with MR assessments (5) Use the assessment schedules/tasks to monitor school performance and track pupil progress (2)	I A A
MISCELLANEOUS	4	0	Minimise your own body language and mannerisms, so as not to distract the child (3) My teaching activities are now designed for specific purposes (9) Use wider range of teaching ideas, with more confidence (9) Reduce the time spent on whole-class teaching (4)	A A A A

The table reveals an interesting diversity of actions, which interviewees have taken or intend to take, following their MR training. When planning the interview procedure, the question about changes in teaching practices seemed initially to the author to be rather 'tacked on', and outside of the Personal Construct Psychology style of the interview. However, during the actual interviews it seemed to flow naturally, for most interviewees. The process of reflecting upon their views during the grid part of the interview seemed to loosen their thinking, and they were keen to formulate their ideas for teaching.

The balance between 'actual' and 'intended' changes is of interest, because it suggests that the interviewees had actually implemented the ideas from the course, in their teaching. There were 40 changes which had been implemented, and 11 which were intended. Given that an average of 1.9 years had passed since the training, it is encouraging that staff were still thinking about new ways of using it in their practice. Looking at which ideas were still to be implemented, it is evident that many of them are to do with school organisation, such as re-grouping children, or are dependent upon expensive staff time, such as delivering individual programmes. Whether it was possible for staff to implement these directly depended upon their position in the school: for example, interviewee 2 was a subject leader for maths, and had therefore been able to implement her idea about using assessments to monitor and track pupil progress across the school. Encouragingly, where staff generated ideas about their own professional practice, they usually said that they had actually implemented these. Overall, the data suggests that staff perceived a rich range of changes to their own practice, at a number of different levels, following their Maths Recovery training.

CHAPTER 6
PHASE TWO: DESIGNING AND INITIAL PILOTING OF THE TOOL FOR STAFF REFLECTION

6.1. INTRODUCTION

In Phase One of the study, staff constructs about the teaching of number were explored through a series of individual interviews, and the resulting data were analysed, in order to explore the ways in which the staff had changed their constructs, following undertaking Maths Recovery training. In Chapter 5, the results from Phase One were discussed in terms of the research questions which were set out in Chapter 3 (section 3.5). We saw that it was possible to address most of the seven research questions, with the exception of Questions 3, 6 and 7. Question 3 asked about the extent to which the constructs of the MR trained staff reflected the documented principles of the MR programme. This question will be addressed in chapter 7, where the results and issues arising from phase 2 will be discussed. Question 6 asked which constructs might need to be explored more deeply, in future Maths Recovery courses. This will be considered in the summary discussion in chapter 8, after the results have been discussed in detail in chapters 5 and 7. Question 7 asked,

> *Can the identified staff constructs be used to create a tool in the form of a brief questionnaire, which staff will find useful in the process of reflecting on their teaching?*

The current chapter will describe how, in Phase two of the study, such a tool was indeed created and piloted.

6.2. PREPARING TO CONSTRUCT THE QUESTIONNAIRE

The first step was to work from the 'Content analysis Table: Interviewer's Final Version' (Table 4.5, p115), which was produced at the end of Phase One.

6.2.1. Reformatting the Content Analysis Table

This content analysis table was reformatted and expanded, by listing the constructs in full, with both the emergent and the contrast poles written out, under each category. The two indices, the 'percent similarity score' and the 'HIL Index' for each construct were listed alongside it. The constructs were all written with the positive pole (i.e. the pole which correlated for the interviewee more highly with the overall summary construct, 'teaches numeracy very well') on the left hand side.

This table was then inspected for potential anomalies, such as apparently similar constructs having very different percent similarity scores. An attempt was made to resolve these anomalies by going back to the interview notes or audio recordings, and reinterpreting or rephrasing the constructs. Any proposed changes were discussed and agreed with the colleague who had assisted in the analysis. Where it was not possible satisfactorily to resolve apparent anomalies, the constructs involved were excluded from subsequent analysis: this resulted in the exclusion of only four constructs, leaving eighty-four in the table. Three of these constructs (numbered 1.2, 1.7 and 6.4) were excluded because of continuing difficulties in interpretation. The fourth, numbered 7.4, was excluded because examination of the data suggested that the interviewee had used the rating scale the wrong way around during the interview.

For each category, some summary statistics were then added to the table: the number of constructs in the category; the percentage of the total number of constructs which this constituted; the Mean Importance Score (i.e. the mean of the percent similarity scores of the constructs within that category).

This reformatted Content Analysis Summary Table, (Table 6.1), with some further work to summarise it which will be described below, was subsequently used as the source of data to create the questionnaire in Phase 2 of the study. (The four constructs which were excluded remain in the table, but have been highlighted, and were not included in the calculation of statistics for the categories.)

Table 6.1: CONTENT ANALYSIS SUMMARY TABLE: Good Teaching, as seen by Maths Recovery Trained Staff

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Knowing about number 6, 7.14% (64.58)	1.6	Very good subject knowledge	V	Very poor subject knowledge	75	I
	4.5	In-depth knowledge of number	V	No knowledge of number	56.25	I
	5.3	Good knowledge of maths	V	Poor knowledge of maths	62.5	L
	9.4	Good knowledge of number	V	Has difficulty working with number – poor subject knowledge	75	I
	10.5	Understands mathematical vocabulary	V	Doesn't understand mathematical vocabulary	56.25	I
	11.3	Good grasp of number	V	Not confident with number	62.5	I
Helping children to enjoy success in maths by positive methods 8, 9.52% (74.21)	2.6	Wants children to enjoy maths	V	Indifference to children's enjoyment	81.25	H
	5.1	Tries to make children enjoy the lesson, through success	V	Just tries to get across information	93.75	H
	8.4	Aim for children to enjoy succeeding	V	Not bothered about how children feel	68.75	I
	1.5	Enthuses children to develop their own learning	V	Motivates children through negative/punitive means	100	H
	3.2	Makes work fun so child wants to learn	V	Motivates by fear – gets cross	50	I
	6.6	Approachable – has time for children	V	Frightening – uses verbal 'put-downs'	75	I
	10.1	Creative, fun way of teaching	V	A lot of pressure to cover mounds of work	56.25	I
	11.8	Makes the lesson fun and interesting	V	Lessons are stressful and difficult	68.75	H

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Empowering children towards independent learning 10, 11.9% (70.63)	2.8	Promotes independent learning	V	Spoon-feeds children	81.25	H
	6.7	Wants children to be confident with their maths	V	Wants children to just listen and understand straight away	87.5	H
	8.8	Empowers children to work confidently and independently	V	Directs children all the time	87.5	H
	10.2	Wants children to work for themselves, and reflect on what they do	V	Wants children to sit and listen – be taught	50	L
	1.8	Facilitates and inspires confidence in others	V	Dictates – tells others what to do	68.75	L
	3.8	Presents task and gives children space to attempt it	V	Presents a task and tells children how to solve it	62.5	H
	7.5	Knows what she wants children to learn, and designs structure to lead there	V	Direct teaching of skills	43.75	L
	10.7	Gives pupils free choice	V	Very strict: doesn't let pupils choose	81.25	H
	4.7	Interacts to draw things from them	V	'Chalk and talk'	68.75	H
	7.4	**'Heads down, silent worksheets'**	**V**	**Encourages child talk and activity in class**	62.5	I
	8.6	Uses questions to prompt children to analyse their own thinking	V	Just marks things right or wrong	75	I

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Differentiating to match tasks and teaching methods to child 10, 11.9% (74.38)	4.2	Starts from where children are	V	Starts from where they think children should be	75	H
	10.8	Builds next step on child's existing understanding	V	Pushes children on when not ready	62.5	H
	2.7	Provides work to stretch each child	V	No differentiation in work provided	87.5	H
	5.2	Differentiates so all children can participate	V	Teaches all children to same level – only differentiates by support	75	I
	6.1	Teaches to fit what individual children can do	V	Teaches what he is told to – follows schemes closely	68.75	I
	8.2	Tries to match teaching method to where the child is	V	Presents generic lessons, based on own expectations	56.25	L
	9.8	Responds to learning needs of pupils at all levels	V	Teaches more able pupils successfully, but struggles to teach less able	75	I
	6.2	Well-informed about what individual children can do	V	Lacks skill in analysing what children can do	81.25	H
	8.7	Assesses knowledgeably and in detail what children can do	V	Makes ignorant assumptions of what children can do	68.75	I
	9.3	Assesses where children are, and matches teaching	V	Unstructured assessment, not related to subsequent teaching	93.75	H
Valuing working with children 3, 3.57% (60.42)	1.3	Tries to give children their absolute best	V	Bone idle – just in the job for the pension!	81.25	I
	9.5	Enjoys working with children	V	Not enthusiastic or tolerant – shouldn't be there!	43.75	L
	9.6	Wants to help children move forward and do their best	V	Wants their pay, and not interested in job satisfaction or helping children	56.25	L

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Enthusiastic commitment to teaching 6, 7.14% (54.17)	4.8	Wants children to enjoy the subject and want to learn more	V	Just comes to work for the monthly payslip	18.75	L
	6.3	Believes that maths is very important, and spends lots of time on it	V	Doesn't enjoy doing or teaching maths, and spends minimum time on it	68.75	I
	7.8	Enthusiastic about the subject	V	Just teaching it because they have to	75	H
	2.1	Committed to the job	V	Marking time, under-performing	81.25	H
	2.2	Enjoys the job	V	Totally disillusioned	68.75	L
	3.6	Dedicated to the job	V	Not bothered about the job – a slacker	12.5	L
Understanding how children learn 2, 2.38% (93.75)	9.2	Understands how children learn	V	Relies on age-related expectations: no idea of structure of children's learning	93.75	H
	11.2	Knows how children learn	V	Doesn't know how children learn	93.75	H
Knowing how children learn number 4, 4.76% (79.72)	2.3	Knows how children learn number	V	No knowledge of how children learn number	81.35	H
	5.4	Understands how children learn maths	V	Poor understanding of how children progress in maths	87.5	H
	6.8	Understands progression in mathematical learning	V	Focus on getting through the curriculum (rather than understanding)	81.25	H
	8.3	Knows about course of children's mathematical development	V	No understanding of children's development	68.75	I

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Respect for children – empathy and high expectations 5, 5.95% (72.5)	8.1	Aims to understand child's thinking	V	Believes child is not capable of understanding	87.5	H
	8.5	Has high expectations for children	V	Has low expectations of children's ability	68.75	I
	3.1	Empathises with child	V	Dictates to child – tells them what to do	75	H
	4.1	Values people for what they are – not prejudiced	V	Prejudiced – no attempt to empathise with others	75	I
	7.6	Has empathy for pupils' problems and feelings	V	Attributes pupil difficulties to lack of ability	56.25	I
Structuring and delivering organised lessons 8, 9.52% (58.59)	2.5	Structures their teaching	V	Haphazard approach to teaching	75	I
	4.3	Structures lessons well, and makes this clear to pupils	V	Disorganized, to an observer	37.5	L
	11.1	Well-organized	V	Not thoroughly planned	62.5	I
	11.7	Brisk-paced lessons	V	Vague, sloppy, purposeless	50	L
	4.6	Great understanding of teaching number	V	No understanding of teaching number	56.25	I
	5.5	Goes back to earlier stage, to find out what the problem is	V	Keeps repeating things if child doesn't understand	81.25	I
	7.3	Breaks work down to make it easy for children to learn	V	Teaches topics as an entity: doesn't think of breaking things down	68.75	H
	11.5	Flexible: changes plans according to pupils' needs	V	Rigidly follows plans: loses sight of pupils' needs	37.5	L

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Teacher development 7, 8.33% (69.64))	3.5	Plans and reflects on teaching	V	Disenchanted – doesn't reflect on teaching	43.75	I
	7.1	Constantly improves teachi8ng skills through experiences	V	Has not improved teaching through experience – 'stuck in a rut'	56.25	I
	9.7	Keen to improve as a teacher	V	Lacks motivation, not interested in the job	68.75	I
	10.6	Eager to learn about teaching	V	Closed to new ideas	62.5	H
	1.1	Works out of 'safe zone' – challenges philosophy and beliefs	V	Always works the same way, sticks with what they know best	93.75	H
	1.4	Does inspirational teaching	V	Doesn't understand what is good practice	87.5	I
	5.6	Blames child if they are stuck – feels irritated by them	V	Blames own teaching for not being at right level	75	I
Managing behaviour in class 3, 3.57% (52.08)	2.4	Good behaviour management	V	Poor behaviour management	68.75	L
	5.7	Good behaviour management, so children are quiet and don't muck about	V	Chaotic, noisy classroom: children off-task	37.5	L
	7.7	Ability quietly to set and maintain behavioural standards in class	V	Finds it difficult to maintain discipline	50	L

Category No, % (Mean importance Score)	Constructs				% Similarity	H-I-L value
Teacher confidence in their philosophy and in their ability to realise it 5, 5.95% (48.75)	1.2	Confident	V	Insecure	93.75	H
	6.4	Self-confident	V	Lacks confidence: 'puts themselves down'	37.5	L
	10.3	Confident, contributes to plans	V	Reluctant to speak out, inflexibly follows plans	37.5	L
	1.7	Has secure belief in their philosophy of teaching	V	Has confused beliefs/philosophy of teaching	68.75	L
	3.4	Knowledgeable and skilled in the classroom	V	Naïve about teaching	25	L
	9.1	Experienced and knowledgeable	V	Lacks experience, less competent	87.5	I
	3.3	Willing to change	V	Inflexible, clings to old methods	43.75	I
	4.4	Relaxed approach, flexible	V	Rigid, inflexible, set ways of doing things	50	I
Personality and style of delivery 3, 3.57% (62.08)	3.7	Patient: is positive and calm, doesn't rush children	V	Impatient: flustered, cross	50	I
	6.5	Laid-back, jovial manner	V	Serious manner, humour not used	50	L
	11.4	Receptive, relaxed, calm	V	Talks over the children – gives no chance to respond	37.5	L
Having a range of teaching ideas and methods 4, 4.76% (68.75)	5.8	Uses a variety of 'props' to help children understand tasks	V	Expects children to work with just numbers, no concrete support	81.25	I
	7.2	Keeps trying different methods to find one which works	V	Perceives only one way of teaching something	68.75	H
	10.4	Has a wide range of teaching ideas	V	Boring, using same methods all the time	56.25	I
	11.6	Understands a range of ways to teach things	V	Has just one way to teach each thing	68.75	H

The Content analysis Summary Table was further summarised as follows. The categories were listed in rank order of their Mean Importance Score. In order further to aid interpretation of the results, subthemes(or definitions) within each category were identified where this seemed possible, and the constructs within each category were ordered to reflect the subthemes. The identification of these subthemes was discussed and agreed with the colleague who had assisted with the original analysis.

Opposite each category, the Subthemes or Definitions were listed, using language created by the author and checked with the colleague. This gave fifteen categories, with twenty-seven Definitions. (See 'Summary of Categories and Definitions', Table 6.2.) Each of the Definitions in this table would eventually form the basis of an item in the questionnaire.

Table 6.2: SUMMARY OF CATEGORIES AND DEFINITIONS

Category (Mean Importance Score)	*Definitions (positive pole)*
Understanding how children learn. (93.75)	Understands how children learn
Knowing how children learn number. (79.72)	Knowing about the course of development of children's learning of number
Differentiating to match tasks and teaching methods to child. (74.38)	Choosing next step according to child's knowledge
	Providing differentiated tasks and support whilst teaching
	Skilful assessment of what individuals actually do and know
Helping children to enjoy success in maths by positive methods. (74.21)	Wanting children to enjoy lessons and build confidence through success
	Motivating children through fun and enthusiasm
Respect for children – empathy and high expectations. (72.5)	Expecting that children will be able to understand
	Empathising with children and supporting them with difficulties
Empowering children towards independent learning. (70.63)	Supporting children towards independent learning
	Using open-ended tasks, facilitation and pupil choice
	Using questions and discussion

Teacher development. (69.64)	Seeking to improve as a teacher, by reflecting on new experiences and ideas
	Experiments with teaching,: tries to 'unstick' pupils with new ideas – inspirational teaching
Having a range of teaching ideas and methods. (68.75)	Having a wide range of teaching methods, equipment and strategies
Knowing about number. (64.58)	Having good knowledge of number
Valuing working with children. (60.42)	Committed to and excited by helping children
Personality and style of delivery. (62.08)	Patient, jovial, receptive and calm
Structuring and delivering organised lessons. (58.59)	Structuring and pacing lessons well
	Deriving teaching strategies from understanding of number
	Changing plans according to pupil need
Enthusiastic commitment to teaching. (54.17)	Believing that maths is import and should have time spent on it
	Being committed to the job: trying hard and wanting to teach number
Managing behaviour in class. (52.08)	Having good behaviour management
Teacher confidence in philosophy & ability to realise it. (48.75)	Feeling confident and contributing to plans
	Secure in beliefs about teaching
	Flexible, willing to change in order to implement philosophy better

6.2.2. Comparing Staff Constructs with Maths Recovery Principles

Having summarised the MR trained staff's constructs about numeracy teaching, the author turned to the published literature on Maths Recovery, to compare these with the principles of MR. There are nine explicit principles of Maths Recovery teaching, as given by Wright et al (Wright et al, 2006, p27), and discussed in Chapter 2 above (section 2.3.4 p 3 and summarised in Appendix K p314). The author considered, for each of the nine principles, whether it was adequately reflected in the lists of constructs and subthemes in the 'Summary of Categories and Definitions' (Table 6.2 p165). If not, the author drafted an item, phrased in language similar to that of the Definitions, to reflect that principle. It was found necessary to draft seven such extra items. The relevance of these extra items was checked with one of the Maths Recovery authors, J. Martland, in informal discussion (Martland, 2006, personal communication).

There is a detailed discussion of this comparison between the Principles of MR and the subthemes generated by the interviewees, in Chapter 7 (section 7.2 p173).

6.3. CONSTRUCTING THE QUESTIONNAIRE

The twenty-seven subthemes from Table 6.2, plus the seven extra items generated by the author, were combined to produce a questionnaire for staff. This was set out and planned in accordance with the advice for structuring questionnaires given by Oppenheim (1992, chapter 7 p101 and Chapter 8 p119). For each item, a contrast pole was generated. The order of items was randomised, and items were randomly presented with respect to the positive pole being on the left or the right hand side. Each item was presented in the format of a Semantic Differential, with a rating ranging from one to five. (See Appendix L p315 for a copy of the questionnaire.)

This questionnaire was intended to be used by future MR trainees as a tool to self-monitor changes in their constructs, with trainees completing a copy of the questionnaire before and after the training, and reflecting upon any changes which they made. It was therefore necessary to design a form through which they could mark their responses, identify any changes in their ratings on particular constructs, and be prompted to reflect upon this information. Such a form was drafted, entitled 'Maths Recovery questionnaire: summary of pre and post course ratings', and a copy is in Appendix M p318.

6.4. PILOTING THE QUESTIONNAIRE

6.4.1. Initial Piloting

The author was able to pilot the questionnaire, with a group of 43 teaching staff who had just completed the MR training course. Staff were asked, at the end of the last of their training sessions, to complete the questionnaire, and to give brief, written feedback about it, focusing on whether it was easy to understand and to use. The staff were also asked to indicate whether they felt that using the questionnaire before and after training would be a helpful exercise for future groups.

As the questionnaire was intended to be a personal, reflective tool, and not a standardised intrument, no data was collected about its reliability. The purpose of the piloting was to check the clarity, ease of use and approachability of the questionnaire.

6.4.2. Results from Initial Piloting

Of the 43 respondents, 35 said that they understood the meaning of the items. Four of the remaining eight people said that they understood most of the items, but they were not specific about which ones they had found unclear.

Item 13 – 'has low expectations of children's abilities/expects that children will be able to understand' – caused difficulties for three people. One person was unclear about its meaning, and two people felt that both poles of this construct were negative. The other 40 people had no difficulty with this construct, and inspection of the 'percent similarity' and HIL indeces for this construct showed intermediate, rather than low, values. It was therefore decided to retain the construct in the questionnaire.

One person had difficulty with item 14, and asked for clarification whilst filling in the questionnaire.

Three people said that some of the questions were not relevant for them because, in their teaching assistant role, they did not work with groups of pupils. It would be difficult to accommodate this in the questionnaire design, as teaching assistant roles vary so widely between schools. It was decided, when using the questionnaire in future, to suggest that people left any such items blank.

The layout of the questionnaire received no negative comments, and was felt to be clear and easy to use. One person said it was too long.

Several respondents took the opportunity to write positive comments about the MR course they had just completed, or about MR itself. Comments included two people saying that the questionnaire, and the course as a whole, had helped them to reflect on their teaching. Five people indicated that the course had given them materials and ideas, and made them keen to go and try these out in school.

The feedback on the questionnaire was taken to be positive, in terms of its layout, content and usefulness. No changes were made to it, before moving on to the further piloting described below.

6.4.3. Further Piloting of the Questionnaire

Having piloted the questionnaire to check its usability by staff, it was important to explore whether it would be feasible as a pre and post-course instrument. The questionnaire was given to a group of 102 staff at the beginning of their first session on a Maths Recovery training course, and again to the 98 of them who attended the final session of the course, seven months later. For each staff member, the author transcribed their responses from the pre-course questionnaire onto a copy of the 'Maths Recovery questionnaire: Summary of Pre and Post Course Ratings' form (Appendix M p318). At the final session of the course, they were each given their form, and shown how to mark their own post-course questionnaire and transcribe their responses onto the summary form. (This took them about ten minutes.) They were invited to highlight constructs on which they had changed a lot, or those on which their final position was towards the negative pole, and to reflect on these. It was suggested that this could inform their professional Performance Management and planning for development.

The summary forms were not returned to the author, who stressed that they were for personal use, as an aid to reflection. However, the staff were also given a brief feedback form, on which they were asked to submit, anonymously, their overall questionnaire scores both before and after the training, and any comments about how they felt they had changed or developed, as a consequence of the course. (See Appendix N p322, for a copy of the feedback form.) The results from this part of the piloting, and a discussion of their implications, are given in Chapter 7 below.

CHAPTER 7
RESULTS AND DISCUSSION OF PHASE TWO

7.1 INTRODUCTION

This chapter will consider issues and results from Phase Two of the study, where the tool for staff reflection was created and piloted.

In the course of creating the tool, it was necessary to address Research Question 3, which asks,

> *To what extent do the staff constructs reflect the documented principles of the Maths Recovery programme?*

This question will be approached through a detailed comparison of the constructs which staff generated in Phase One with the nine Principles of Maths Recovery, which were discussed in Chapter 2 above. This comparison will make clear the need for additional items, derived from the nine Principles, to have been added to the staff constructs, when designing the Phase Two questionnaire.

The chapter will then discuss the results from piloting the questionnaire. Results from the initial piloting, which was used to check how user-friendly the format and language of the questionnaire was, have already been discussed in Chapter 6 above. This chapter will consider the results from further piloting the questionnaire, with a group of 98 staff that used it before and after completing their MR training course. This will shed further light on the second part of Research Question 7, *Can the identified staff constructs be used to create a tool in the form of a brief questionnaire, which staff will find useful in the process of reflecting on their teaching?*

This will lead on to a discussion of how the questionnaire might be developed further, to increase its usefulness in staff reflection and in improving the delivery of the MR course.

7.2 STAFF CONSTRUCTS AND MATHS RECOVERY PRINCIPLES

Research Question 3:

To what extent do the staff constructs reflect the documented principles of the Maths Recovery programme?

The Maths Recovery programme clearly states nine 'Guiding Principles for MR Teaching' (Wright et al, 2006), which are discussed in Chapter 2 above (section 2.3.4) and are also listed in Appendix K p314. Each of these principles will be taken in turn, and the relationship between it and the constructs generated by staff (as summarised in the Interviewer's final version of the Content Analysis Table, Table 4.3 on page 115, and the Summary of Categories and Definitions, Table 6.2 on page 165 and also given as a numbered list in appendix J p 310) will be discussed.

Principle 1:

The teaching approach is enquiry based, that is problem based. Children are routinely engaged in thinking hard to solve numerical problems that for *them are quite challenging.* (Wright et al, op cit)

The staff constructs do not contain explicit reference to the problem or enquiry-based approach. 'Understanding how children learn' is seen by the interviewees as the category which is most closely related to the good teaching of numeracy (with a Mean Importance Score of 93.75), but an examination of the notes taken during the interviews suggests that this understanding relates mostly to the stages of children's learning, with little reference to what teachers might do to facilitate the process of children constructing their knowledge.

The idea of hard thinking on challenging problems is partially reflected in the staff constructs category of 'Differentiating to match tasks and teaching methods to child', which contains many constructs referring to providing tasks which are differentiated according to each child's needs, but does not focus strongly on 'hard thinking' from each child. It is also partially reflected in the staff constructs category of 'Empowering children towards independent learning', which includes the construct (3.8), 'presents a task and gives children space to attempt it, versus presents a task and tells children how to solve it'.

The following item (item 31) was added to the questionnaire, to achieve coverage of Principle 1:

Teaches in enquiry based manner, with children thinking hard to solve challenging problems	V	***Teaches in a didactic manner, with teacher directly transmitting knowledge***

Principle 2
Teaching is informed by an initial, comprehensive assessment and ongoing assessment through teaching. Assessment through teaching refers to the teacher's informed understanding of the child's current knowledge and problem-solving strategies, and continual revision of this understanding.
(Wright et al, op cit)

There are many references to this principle, in the interviewee constructs. Assessment is seen as a facet of differentiation. Interviewees make reference to having skills to assess (construct 6.2), making observations rather than assumptions (construct 8.7), and relating assessment to ongoing teaching (construct 9.3). There is, however, no explicit reference by the interviewees to the continuous nature of assessment, in assessment through teaching.

The following item (number 19) was added to the questionnaire, to ensure full coverage of Principle 2:

Teacher assesses continuously through teaching, always revising their understanding of child's knowledge	V	***Teacher uses assessment in a static way, at fixed point in time and for summative purpose only***

Principle 3

Teaching is focused just beyond the 'cutting edge' of the child's current knowledge. (Wright et al, op cit)

The interviewees place strong emphasis on taking the child's current knowledge into account, when choosing the next step in teaching. The category 'Differentiating to match tasks and teaching methods to child' includes constructs about this (4.2, 10.8). However, there is not a direct reference to the need to focus just beyond the 'cutting edge'.

The following item (number 4) was added to the questionnaire, to ensure full coverage of Principle 3:

Teaches just beyond the 'cutting edge' of each child's current knowledge	V	***Does not match teaching or tasks to child's performance***

Principle 4

Teachers exercise their professional judgment in selecting from a bank of instructional settings and tasks, and varying this selection on the basis of ongoing observations. (Wright et al, op cit)

This principle is strongly represented, in the interviewee constructs. Selecting from a bank of settings and tasks is covered in the category, 'Having a range of teaching ideas and methods' (constructs 5.8, 7.2, 10.4, 11.6). Varying the selection is covered in 'Differentiating to match tasks and teaching methods to child' (constructs 2.7, 5.2, 6.1, 8.2, 9.8).

Principle 5

The teacher understands children's numerical strategies and deliberately engenders the development of more sophisticated strategies. (Wright et al, op cit)

The idea of understanding children's numerical strategies is reflected in the interviewee categories of 'Knowing how children learn number', and in the assessment strand within 'Differentiating to match tasks and teaching methods to child' (constructs 6.2, 8.7, 9.3). The engendering of more sophisticated strategies is not explicitly referred to, although there are references to the more general idea of teachers acting as facilitators to help children develop, e.g. in the category 'Empowering children towards independent learning', where construct 7.5 appears, 'knows what she wants children to learn, and designs structures to lead there V direct teaching of skills'.

The following item (number 21) was added to the questionnaire, to ensure full coverage of Principle 5:

Uses understanding of children's numerical strategies, to help them to develop more sophisticated ones	V	***Focuses on children getting correct answers: no interest in their strategies***

Principle 6

Teaching involves intensive, ongoing observation by the teacher and continual micro-adjusting or fine-tuning of teaching on the basis of her or his observation. (Wright et al, op cit)

There are no specific references to micro-adjusting on the basis of ongoing observation, in the interviewee constructs. However, the categories of 'Differentiating to match tasks and teaching methods to child' and 'structuring and delivering organised lessons' contain some relevant constructs, which focus on the teacher being flexible about the choice of what to do next, in response to child performance. Constructs 4.2, 10.8, 2.7, 5.2, 6.1, 8.2, 9.8, 9.3 and 11.5 are particularly relevant here.

The following item (number 27) was added to the questionnaire, to ensure full coverage of Principle 6:

Makes intensive observations of pupils whilst teaching, and continually adjusts teaching on basis of these	V	***Disregards pupil responses, and keeps rigidly to a pre-planned course***

Principle 7

Teaching supports and builds on the child's intuitive, verbally based strategies and these are used as a basis for the development of written forms *of arithmetic that accord with the child's verbally based strategies.* (Wright et al, op cit)

There are no interviewee constructs which relate specifically to this principle, although there are more general references to the need to start from where the child actually is, in the category, 'Differentiating to match tasks and teaching methods to child'. The issue of how written methods are related to children's earlier strategies was not mentioned by the interviewees.

The following item (number 14) was added to the questionnaire, to ensure full coverage of Principle 7:

Starts from child's intuitive, verbal strategies, and bases development of written methods on these	V	***Starts with direct teaching of standard, written methods***

Principle 8

The teacher provides the child with sufficient time to solve a given problem. Consequently the child is frequently engaged in episodes that involve sustained thinking, reflection on her or his thinking and reflecting on the results of her or his thinking. (Wright et al, op cit)

The first part of this principle, about sustained thinking on problems, overlaps with Principle 1 above, and the comments made above are relevant:

interviewees did consider child's sustained thinking, under the categories of Differentiation and Empowerment.

The second part of this principle, about child reflection, is touched upon in the category, 'Empowering children towards independent learning', although the interviewees spoke more about what they, as teachers, would do to promote child reflection, rather than about what kind of thinking the child would be doing. The most directly relevant construct generated was 10.2, 'wants children to work for themselves and reflect on what they do V wants children to sit and listen – be taught'.

Principle 9

Children gain intrinsic satisfaction from their problem-solving, their realization that they are making progress and from the verification methods they develop. (Wright et al, op cit)

There are many references by interviewees to children's motivation through success, their awareness of progress and their enjoyment. These appear in the categories, 'Helping children to enjoy success in maths by positive methods' and 'Empowering children towards independent learning'. There is, however, no mention of children gaining satisfaction from developing verification methods.

The following item (number 8) was added to the questionnaire, to ensure full coverage of Principle 9:

Wants children to develop verification strategies, and to have intrinsic satisfaction from this	V	***Satisfied if children have just one method to solve a problem, and they get the right answer***

Thus we see that most of the principles given by Wright et al were reflected in the constructs generated by the interviewees, although there are some gaps. These gaps will be further discussed later, in Chapter 8 (section 8.2.3 p210), where consideration will be given to possible improvements to be made to the delivery of future Maths Recovery courses.

It is noticeable that there are several categories of interviewee constructs which do not appear in the list of principles given by Wright et al. This is to be expected, as the interviewees were asked to consider the teaching of number in general, in the context of their experiences as teachers, rather than just Maths Recovery teaching. These extra categories of constructs seem to relate either to superordinate teacher beliefs and values, or to general classroom manner. They are:

- Valuing working with children
- Enthusiastic commitment to teaching
- Respect for children – empathy and high expectations
- Teacher confidence in their philosophy and in their ability to realise it
- Teacher development
- Personality and style of delivery
- Managing behaviour in class

These categories are outside the range which Wright et al's nine principles were designed to cover, but are very important for the interviewees, who need to set their use of Maths Recovery within the wider context of themselves as teaching staff in the school context. The fact that the staff generated so many constructs in these categories suggests that they have applied their MR learning, reflected on it and integrated it into their constructions about teaching.

7.3 PILOTING THE STAFF QUESTIONNAIRE

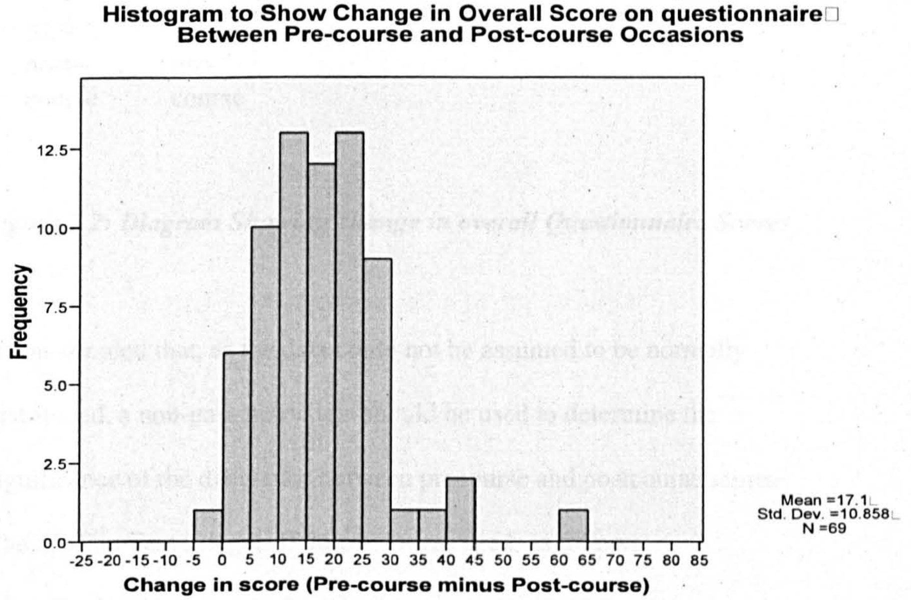
The initial piloting of the questionnaire, described in Chapter 6 above, suggested that staff found it reasonably easy to use, and generally understood the language used. Further piloting was then carried out, using the questionnaire before and after the MR training, for a group of 102 staff. Only 98 of the staff completed the course, so data was potentially available from these 98 staff. However, there were some difficulties about acquiring this data. The main purpose of the questionnaire was to aid staff reflection, so it was very important that staff were left in possession of their data, and that they were confident of its confidentiality. To achieve this, the author collated and scored the pre-course questionnaires, then returned them to the staff for completion and self-scoring of the post-course questionnaire, which took place during the last session of the course. This meant that the author was present during the self-scoring, and was able to help with any difficulties which arose, as well as being available if any staff wished to discuss their results. However, it also meant that the author did not have access to the post-course data. It was decided to ask the course participants to fill in a brief feedback form, giving their pre and post overall questionnaire scores, and asking them for their comments on any change they might have experienced as a consequence of the course. They were also asked to nominate the two constructs on which they felt they had improved least, and the two on which they had improved most. (See Appendix N, p 322 for a copy of the form.) Seventy-six completed feedback forms were received: the remaining staff were either absent from the last part of the session, or chose not to complete the feedback form. Some staff found it hard, in the time available, to collate their scores and calculate the changes. The author offered step-by-step instructions and support, but this was still an issue, because of the different rates at which people worked when completing the questionnaire, and the limited time available during the session. Some staff supported others with the task: although they probably intended this to be helpful, it did breach the confidentiality of responses, especially where teachers offered support to the assistants with whom they normally worked. The experience of doing this collating in a 'live' training session caused the author to resolve to find another, less pressured and more confidential way of doing it, for future cohorts.

Sixty-nine of the returned forms had data which was complete enough to enable some statistical analysis of the results. The changes in overall scores will be considered first, then the data about least and most improved constructs and then the qualitative comments.

7.3.1 Differences Between Pre-Course and Post-Course Scores

Firstly, the amount of change in the staff's overall questionnaire scores, between the pre-course and post-course administrations, was considered. This is shown in Table 7.5 (Appendix O p323) and represented graphically in figure 7.1.

Figure 7.1: Histogram to show change in overall scores on questionnaire



It will be seen that there was a mean change in score of 17.1 scale points. Given that there were 34 constructs, and each was assessed on a 5-point scale, this shows considerable change in staff constructs about themselves as numeracy teachers. The maximum possible score on the questionnaire was 170, and the minimum was 34 (where low scores are associated with good teaching). The mean score for the 69 staff at the start of the course was 70 and at the end of the course was 52.9, so one can infer that they began with a positive view of themselves and ended with an even more positive view. This represented diagrammatically below, in figure 7.2:

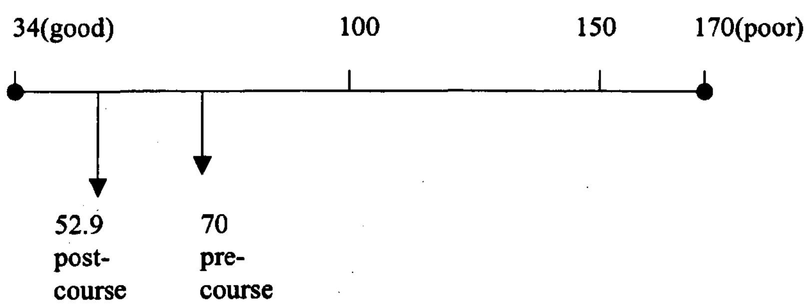


Figure 7.2: Diagram Showing change in overall Questionnaire Scores

It was decided that, as the data could not be assumed to be normally distributed, a non-parametric test should be used to determine the significance of the difference between precourse and postcourse scores. The Median Test (Siegel, 1956 p111) was used, as follows:

The Null Hypothesis was that there is no difference between the medians of the precourse and postcourse scores. The alternative hypothesis, using a one-tailed test, was that the median postcourse score was lower than the median pre-course score. The data for the Median Test is summarised in Table 7.1 below:

Table 7.1: Summary Table for Median Test on Precourse and Postcourse scores

Combined Median of Precourse & Postcourse Scores = 60.1

	Precourse Scores	Postcourse Scores
No. scores above Combined Median	50	19
No. scores below Combined Median	19	50

The significance of this data was tested by calculating Chi Squared and using a table of its critical values (Siegel, op cit).

$$\chi^2 = \frac{138\,(\,|50^2 - 19^2| - 138/2)^2}{(50+19)\,(19+50)\,(50+19)\,(19+50)} \quad = 26.09$$

$\chi^2 \geq 26.09$ with one degree of freedom has a probability of occurrence under the null hypothesis of

$p < ½(0.001) = p < 0.0005$, for a one-tailed test.

Thus the null hypothesis was rejected, and it can be concluded that the median postcourse score was significantly lower than the median precourse score.

In order to give some guide as to the importance of the change in the scores, an Effect Size was computed. A commonly-used method of calculating Effect Size is described by Coe and by Cohen (Cohen, 1969; Coe, 2000; Coe, 2002), who provide useful guidance about the subjective interpretation of the obtained value. However, as Coe (op cit) points out, this statistic does assume the data is normally distributed, and is actually quite sensitive to deviations from this assumption. It was therefore decided, for the data in this study, to use an alternative measure, **d**, which is "a direct nonparametric measure of effect size" (Cliff, 1993). The value of **d** was calculated as shown below, following the procedure in Cliff (1993, p495).

d = 2U/nm – 1 where U is the Wilcoxon-Mann-Whitney U statistic, and n and m are the numbers of data items in each group:

U = 6276 -2415/2 = 3861

$$\mathbf{d} = \frac{2 \times 3861}{69 \times 69} - 1 = \mathbf{0.622}$$

This Effect Size of 0.622 is difficult to interpret meaningfully. As Thomson points out (Thomson, 2007), effect sizes need to be interpreted through direct comparison with those in relevant, prior literature, rather than by the use of benchmarks such as those given by Coe and Cohen. There are, however, no published prior relevant studies with an effect size quoted. It is worth noting that , as the precourse scores were already quite low, as shown in Figure 7.2 above, there may have been some 'ceiling effect' operating. Overall, the statistical analysis does strongly suggest that staff rated themselves more positively after the course than before it. There was actually only one staff member whose post-course score was higher , (i.e. worse) than her pre-course score, and this was by only one point. This person, who was a teaching assistant, chose to discuss her results with the author. She said that she actually felt she had learned a lot, and improved as a teacher, over the time of the course. However, it had made her realise how much she had still to learn, and she felt that she had been too positive in her pre-course ratings of herself.

Consideration was given to whether the number of years of experience, or the role as a teacher or a teaching assistant, was correlated with the degree of change on the questionnaire. For the years of experience, a Spearman's rho correlation was calculated (See Table 7.2 below).

Table 7.2: Correlations between Years of Experience and Change in Questionnaire Score

Correlations: Spearman's rho

		years experience	Pre-score	Post-score	Difference (Pre-Post)
years experience	Spearman's rho Correlation	1	-0.02	-0.057	-0.01
	Sig. (2-tailed)		0.867	0.644	0.933
	N	69	69	69	69

These very low correlations suggest that there was no relationship between the staff members' years of experience and their scores on the questionnaire, either before or after the training. Also, there was no relationship between their years of experience and the amount of change in their questionnaire scores. The author found this encouraging, as it suggests that the course was equally able to effect changes in staff constructions, with both very experienced and less experienced staff.

For the role (i.e. that of teacher or teaching assistant, where there were 33 teachers and 36 teaching assistants) the Mann-Whitney U statistic was calculated, and its significance tested by calculating z and using its close approximation to the normal distribution (Siegel,1956, p121).

U = 485

$$z = \frac{U - n_1 n_2/2}{\sqrt{(n_1 n_2 (n_1 + n_2 + 1)/12}} = 0.016$$

This low value of z would not justify the rejection of the Null Hypothesis, that there is no difference between the amounts of change on the questionnaire scores which were made by teachers and by teaching assistants.

This suggests that there was no relationship between whether someone was a teacher or an assistant, and the degree of change in their constructions of themselves as good teachers. This, too, was encouraging, as it suggested that both teachers and teaching assistants had been able to engage with the reflective process, to a similar degree.

7.3.2 Most and Least Improved Constructs

This data proved very difficult to analyse and to interpret. Because most respondents rated themselves positively on many of the constructs in the pre-course questionnaire, they showed no or only slight improvement on many of the contructs. This led to multiple ties on both 'most improved' and 'least improved', for many respondents. The data therefore has to be treated with caution. Table 7.3 below shows how many times each construct was nominated as 'most improved' or 'least improved'.

Table 7.3: Most and Least Improved Constructs form Questionnaire, as Nominated by the Staff

Construct no.	*Positive pole of Construct*	*No. of times nominated as most improved*	*No. of times nominated as least improved*
23	Knows about course of children's number learning	15	1
2	Has good knowledge of number	13	1
8	**Wants children to verify & get satisfaction thence**	**9**	**0**
9	Has wide range of teaching methods, equipment & strategies	8	0
31	**Enquiry-based teaching, hard thinking & challenge**	**6**	**1**
10	Skillful assessment of what children know & can do	5	1
14	**Starts from intuitive, verbal strategies – written derived**	**5**	**0**
12	Experiments to 'unstick' pupils - inspirational	4	2
17	Has good understanding of how children learn	4	0
29	Feels confident and contributes to plans	4	1
3	Secure in beliefs about teaching	3	2
4	**Teaches just beyond the 'cutting edge'**	**3**	**3**
16	Uses open-ended tasks, facilitation & pupil choice	3	1
21	**Helps children to develop more sophisticated strategies**	**3**	**1**
30	Supports children towards independent learning	3	0
33	Derives teaching strategies from understanding of number	3	1
1	Chooses next teaching step according to child's knowledge	2	0
6	Believes maths is im portant & should have time spent on it	2	2
7	Flexible, will change to implement philosophy better	2	0
13	Expects that children will be able to understand	2	2

Table 7.3 (contd.)

Construct no.	*Positive pole of Construct*	*No. of times nominated as most improved*	*No. of times nominated as least improved*
20	Seeks to improve teaching by reflecting on new ideas	2	1
24	Motivates children through fun & enthusiasm	2	0
27	**Makes intensive observations, uses to adjust teaching**	**2**	**2**
32	Committed to & excited by helping children	2	0
5	Changes plans according to pupil need	1	2
18	Structures and paces lessons well	1	3
26	Provides differentiated tasks & support whilst teaching	1	2
11	Wants children to enjoy & build confidence through success	0	0
15	Patient, jovial, receptive & calm	0	1
22	Has good behaviour management	0	2
25	Uses questions and discussion	0	0
28	Tries hard, wants to teach number – committed to the job	0	0
34	Empathises with children & supports them with difficulties	0	1

The table is ordered with the constructs most frequently nominated as 'most improved' at the top. The constructs in bold type are the ones which were derived directly from the nine MR aprinciples, and were added to those generated by the staff. Rows have been highlighted for discussion where they contain particularly high values, although it is important to bear in mind the caveat above.

Contruct 2, 'Has good knowledge of number', was cited 13 times as most improved, and only once as least improved. Similarly, construct 23, 'knows about the course of development of children's learning of number', was cited 15 times as most improved, and only once as least improved. The staff felt that the course had increased their knowledge both of numeracy and of the learning of numeracy.

Construct 8, 'satisfied if children have just one method to solve a problem, and they get the right answer – versus - wants children to develop verification strategies, and to have intrinsic satisfaction from this', was nominated 9 times as most improved, and not at all as least improved. This is interesting, as this construct was one which was derived from Wright et al's nine Principles, and added to those generated by the staff in Phase One. It seems that, although staff may find it difficult to articulate this idea themselves, it was a meaningful dimension of positive change for many of them.

Construct 9, 'has a wide range of teaching methods, equipment and strategies', was nominated as most improved by 8 staff, and as least improved by none. This accords with the previous observation, in 7.2 above, that the staff-generated constructs represented Wright et al's

Principle 4 (about selecting appropriately from a bank of settings and tasks) very well. It seems that the staff had found the course helpful in developing this practical aspect of their work.

Construct 31, 'teaches in didactic manner, with teacher directly transmitting knowledge – versus – teaches in enquiry based manner, with children thinking hard to solve challenging problems', was nominated as most improved by 6 people, and as least improved by one. Again, this construct was one which had been added to the Phase One pool through reference to the Nine Principles. It is central to the constructivist philosophy of Maths Recovery, and course tutors had hoped that staff would move towards the 'enquiry based' end of this construct. It is encouraging to see that some staff did nominate this construct as their most improved one. Because the complete post-course data was not obtained from staff, a more detailed analysis of whether staff had generally shifted on this construct is not possible at this stage. A possible method of getting this data, for future courses, will be suggested below, and further developed in the final chapter.

7.3.3 Qualitative Comments by Staff

Many of the staff made qualitative comments on the feedback sheets, about how they thought they had changed as a result of the course. An informal content analysis of these was made, by grouping similar comments into a category and giving the category a description, in a procedure similar to Step 2 of the content analysis used for the staff constructs (as described in Chapter 4, 4.3.4). This analysis of staff comments is summarised below, in Table 7.4.

TABLE 7.4: Summary of Staff Comments on How They Have Changed as a Result of the Course

Description of Category	*No. of comments*	*Summarised Comments*
Better understanding of children's learning	13	• Better understanding of the way children develop knowledge of number, and how this affects my teaching • More confident in understanding children's learning of number • Greater understanding of how children develop an understanding of number, and how to move them on • Greater understanding of how children learn – the finely-graded developmental stages • Better understanding of development and levels • Better understanding of how children learn • Knowledge of children's number development • Knowledge of the child's 'learning path' • Better understanding of the course of development of children's learning of number • More confident in understanding of knowledge of number • Better understanding of how a child progresses in number work • Changed understanding of the development of number • Developed a greater understanding of how children learn number

Description of Category	*No. of comments*	*Summarised Comments*
Confident to plan and differentiate in group and/or class teaching	8	• More confident - I take a more open view of lessons: has a knock-on effect in all my school work, not just maths • More confident • I feel lots more confident at delivering KS1 maths to a whole class, and more able to pitch learning at the right level • I feel much more confident about teaching numeracy • Much more confident and aware of teaching and assessing children about number • Increased confidence working with numeracy generally • Feel very positive and confident now to do small-group maths work in school • More confident, with better knowledge and understanding
Confident to differentiate, in individual teaching	6	• More confident to plan tasks to meet specific needs of individuals • Gained confidence in delivery of maths activities • Much more confident about what to do when child is stuck • I feel able to come 'out of the box' more when delivering individual lesson • Better differentiation of tasks • More confident at making observations of pupils whilst teaching, and changing teaching methods to suit individuals as a result

Description of Category	*No. of comments*	*Summarised Comments*
Understanding of children's strategies	6	• Better understanding of strategies children use • Better understanding of strategies • Greater understanding of small steps • Different way of looking at children's strategies • Better understanding of strategies open to children, and how this scan influence their development. I feel more comfortable assessing strategies, now • Understanding of strategies and progression
Know how to help children to progress	3	• Knowledge of how to help children progress to the next stage (3 identical comments)
Wide range of teaching strategies/methods	3	• Understanding of how maths skills can be embedded through fun, practical activities • More aware of strategies to use to help children access maths more easily • Wider range of teaching methods, equipment and strategies
Logistical/time pressures	3	• Delivery of MR very logistically difficult, therefore stressful – shortage of time • Tired, from an exhausting regime • Pressure of time affects planning, delivery and patience when working with child
Thinking time	2	• I listen to children more, and wait for an answer • Give children thinking time

Description of Category	*No. of comments*	*Summarised Comments*
Problem-solving approach	2	• I aim to have a more problem-solving approach to maths and be less driven by content coverage • Better understanding of problem-solving approach
Teacher enjoyment	2	• I feel very upbeat about the teaching of maths and look forward to using it in the future • I now enjoy working with maths, with the children
Verification strategies	2	• I now want children to develop verification strategies (2 identical comments)
Miscellaneous	7	• Importance of making sure a child has a secure understanding of concepts • Push children's current knowledge • Improved ability to recognise what you do actually know • I now don't stick rigidly to my plans • More able to understand why children struggle, so more patient and have more ideas to help them • MR clashes with the dictates of the National Curriculum • I was already very sure of my strengths and weaknesses as a teacher, so the MR training has not really changed my self-perception.
Difficulties in completing questionnaire	7	These comments were about difficulties with calculating total, and running out of time to find errors with this, or about being unable to compare pre- and post- results because they had not fully completed the pre-course questionnaire.

There is an interesting congruence between some of these comments, the constructs which were frequently nominated as 'most improved' and the constructs which had been derived from the Nine Principles rather than from the interviews. To illustrate this:

- The categories, 'understanding children's strategies' and 'know how to help children to progress' relate closely to Item 21 in the questionnaire, 'Uses understanding of children's numerical strategies, to help them to develop more sophisticated ones'. This item was derived from the Nine Principles.
- The categories, 'confident to plan and differentiate in group/class teaching' and 'confident to differentiate in individual teaching' relate closely to Item 4 from the questionnaire, 'teaches just beyond the cutting edge of each child's current knowledge'. This item was derived from the Nine Principles.
- The category, 'problem-solving approach' is related to Item 31, 'teaches in enquiry-based manner, with children thinking hard to solve challenging problems'. This item was derived from the Nine Principles, and was also nominated as 'most improved' by six people.
- The category, 'verification strategies' relates to Item 8, 'Wants children to develop verification strategies, and to have intrinsic satisfaction from this'. This item was derived from the Nine Principles, and was nominated as 'most improved' by nine people.

This gives further evidence to suggest that some of the constructs which the original interviewees did not articulate are nevertheless important dimensions on which staff views do shift, through the experience of Maths Recovery training. The author hypothesizes that the cohort of trainees who completed the pre and post-course questionnaires had their awareness of these constructs raised, and were thus helped to reflect upon them. This resulted in some trainees either nominating these constructs as areas of improvement, or articulating them in their own words on the comments sheet. The use of the questionnaire, then, did perhaps have some effect in helping staff to reflect upon their development. A more complete collecting of the questionnaire data followed by a systematic analysis of it, which was not undertaken for the reasons discussed above, might have shed more light on this issue.

7.4 SUMMARY

The results from comparing the constructs generated in Phase One interviews with the Nine Principles of Maths Recovery showed that, to a great extent, the staff-generated constructs did reflect the documented principles of the Maths Recovery programme. They were not, however, a complete reflection of it. In constructing the Phase Two questionnaire, it was necessary to add seven items which were derived directly from the MR principles, to the twenty-seven items which were derived from the Phase One interviews, in order fully to reflect the principles of the MR programme.

In piloting the questionnaire with a group of 98 trainees, it was found that most of them were able to understand and use the questionnaire as a pre and post-course exercise, although some had difficulty with collating and interpreting their results. Some issues of confidentiality also arose, as the author was able to see people's pre-test scores, and the participants were often able to see each other's scores. The data obtained was incomplete, and the qualitative data was quite difficult to interpret. Nevertheless, the use of the questionnaire gave some evidence that the course participants believed that their own constructs about the teaching and learning of number had shifted as a consequence of the course, in the direction of better practice. There is also some evidence that the questionnaire was acting as an aid to staff reflection, as had been intended.

In order to make the questionnaire a more effective and useable tool, it would be necessary to address the issues of confidentiality, sufficient time to collate and reflect on the results, and more individualised and structured guidance to aid the reflective process. This might be achieved through presenting the questionnaire as an on-line exercise, with automatically generated individual results and with guidelines for reflection included. Participants would be able to take as much time as necessary, and to have a free choice about whether and with whom they shared their results. The trainers would also be able to get anonymous data about how much each construct had changed, across the whole cohort of trainees. This could be powerful information in helping trainers to improve the course. This idea for future development of the questionnaire will be discussed in more detail, in the final chapter.

CHAPTER 8
DISCUSSION AND CONCLUSIONS

8.1 INTRODUCTION

This study has focused on how, for a group of teachers and teaching assistants, the experience of training in and applying the Mathematics Recovery approach to numeracy teaching affected their constructs about the teaching and learning of numeracy. The methodology which was used to explore staff constructs, that of Personal Construct Psychology, was chosen so as to minimise the possibility of the interviewer donating ideas or constructs, and to enable a sharing of staff ideas through Phase Two of the study. This methodology was used to address the seven Research Questions, which were set out in chapter 3 (section 3.5 p77), and the results have been discussed in detail in chapters 5 and 7 above. The current chapter will return to consider the original aims of the study, which were set out in Chapter 3 (section 3.1 p72), and from which the seven Research Questions were derived.

Emerging from this discussion of how the aims of the study have been addressed, there will be a consideration of some broader issues which arose. The issues which were highlighted in the literature review (chapter 2, pp16 – 67) will also be considered, in relations to the findings of the present study. In the course of discussing these issues, there will be consideration of the implications of the results of the study, for the future implementation of Mathematics Recovery training.

8.2 AIMS OF THE RESEARCH STUDY

In this section, each of the main aims of the study, as listed in Chapter 3 (section 3.1 p72) will be considered in turn, with a summary of how the results related to that aim, and some interpretive comments and suggestions for future directions.

8.2.1 Aim 1: To explore teaching staff's constructs about the teaching and learning of number

Phase 1 of the study addressed this aim, through conducting the Personal Construct Psychology interviews with eleven staff, and reflecting the results back to the interviewees. It was found that the PCP interviews were an effective method of getting the staff to talk about their constructs around the area of the teaching and learning of mathematics, and all eleven staff were able to generate at least eight distinct constructs. In order to support staff in doing this, it was necessary to use a range of PCP techniques: ladders, pyramids, triads, character sketches and general discussion. Previous research (Hardison & Neimeyer, 2007) suggests that different PCP techniques are effective at eliciting different types and themes of constructs. A wide range of constructs was in fact generated in the current study, including behavioural, attributional, evaluative and affective. There were some peripheral constructs, but most were more 'core': they had well-developed relationships to the rest of the interviewee's construct system, and were regarded by the interviewee as being important. (See appendix J p310, for the full list of constructs.)

In order to reflect their data back to the interviewees, it was necessary to present the data in a coherent, concise form. This was achieved through producing, for each interviewee, a numerical summary of the ratings for elements and constructs, together with verbal interpretations of the meaning of the data. These verbal interpretations included an account of what the interviewee considers good numeracy teaching to be like, and an account of their own development as a teacher of numeracy.

The accounts of good numeracy teaching were found to have several elements in common: pupil-focused motivation, valuing and empathising with pupils, understanding children's learning, individualising instruction according to each child's knowledge, and staff themselves having good mathematical knowledge. These accounts were consistent with constructivist ideas about teaching, as reviewed in chapter 2 above (e.g. Hmelo-Silver, 2004; Kumar & Natarajan, 2007; Freudenthal, 1991). This suggests that, by the end of their MR course, staff had some commitment to a constructivist view of teaching. However, there were many aspects of the nine (constructivist) principles of MR teaching which were missing from the staff descriptions of good numeracy teaching. These included:

- enquiry-based teaching - child thinks hard about challenging problems
- ongoing assessment
- focusing just beyond the 'cutting edge'
- engendering more sophisticated strategies
- micro-adjusting in response to ongoing observation
- building written strategies on earlier intuitive, verbally-based ones.

The author was puzzled about why, even though staff were rating themselves as having changed a lot in response to MR training and said they had changed their teaching practices considerably, they were not apparently subscribing to many of the constructivist principles of MR. As remarked above, their accounts of good numeracy teaching are consistent with constructivist principles, but they often seem to miss the essence of radical constructivism. Their accounts are almost always still framed in the language of teacher behaviour, rather than being focused on how the children learn. The exception to this is when staff talk about pupil motivation and enjoyment. It is as though staff, because of their past history within the education system, find id difficult to let go of a controlling, highly structured teaching style, and to trust in the pupils' ability to learn. The staff constructs are explored in more detail and compared to the nine principles of MR, in section 8.2.3 below, where some suggestions are made about how future MR courses might encourage a more reflective stance, in order to facilitate the development of a more constructivist orientation.

Although staff were offered an opportunity to engage in a dialogue about their feedback sheets, few of them availed themselves of this. This could be interpreted in various ways: perhaps they felt the feedback was accurate and clear, or perhaps they were too busy or too shy to seek further discussion, or perhaps they needed more guidance about how they might make use of such feedback.

8.2.2 Aim 2: To find out how teaching staff perceive their constructs to have changed, after they complete a programme of Maths Recovery training

This aim was addressed in two main ways. For each interviewee, the verbal interpretation referred to in 8.2.1 above (p207) included a paragraph on their development as a numeracy teacher, since the start of the course. (This was constructed by comparing their ratings of 'me now', 'me just before MR training' and 'me when new to teaching', across the constructs which they had generated, as well as the donated Construct 9, 'teaches numeracy very well'.) These paragraphs are given in Chapter 5, in column 3 of Table 5.2 (p127). Each interviewee was able to identify ways in which they felt they had improved as a numeracy teacher, since the start of their MR training. As discussed in Chapter 5, it would not be meaningful to attempt to summarise commonalities between these paragraphs. However, the following positive changes were all mentioned, each by a different interviewee:

- Goes back to first principles now, instead of 'plugging gaps'
- Less directive, more a facilitator of children's problem-solving
- Starts from where the children are, and teaches flexibly
- Understands the teaching of number
- Doesn't repeat previous, unsuccessful approaches, but tries a new one
- Has increased confidence in himself as a teacher
- Breaks tasks down more, and evolves new methods to teach things
- Assesses more effectively, and can understand what children do
- Teaching assistant now shares planning effectively with a teacher

- Knows about how children learn
- Has a wider range of ways to teach things.

As can be seen from this list, the changes which staff mentioned include conceptual changes, and not just specific skills or techniques. This is very encouraging, as it suggests that the staff would be equipped to continue their development, after the end of the formal MR course.

As well as the qualitative analysis of staff constructs, an attempt was made to use the staff ratings of themselves on Construct 9, 'teaches numeracy very well', to quantify the improvement which they felt they had made. As was discussed in Chapter 5 (section 5.6.2 p142), this data is not suitable for statistical analysis. However, it does suggest that the staff perceived themselves to have improved much more quickly, in response to the MR training, than they had done in their previous years of experience in teaching.

8.2.3 Aim 3: To evaluate the extent to which the principles of Maths Recovery are reflected in the construct systems of the trained staff

In order to address this aim, the constructs which the staff generated in Phase One of the study were compared with the nine published Principles of the Mathematics Recovery programme (Wright et al, 2006a, also listed in Appendix K p314). It was hoped that the constructs generated by the staff would fully reflect the nine Principles. In fact it was found that, although the generated constructs did cover most of the nine Principles, there were some gaps. In order to ensure complete coverage when drafting the Phase Two questionnaire, it was necessary to add seven new items to the twenty-seven which had been derived directly from the constructs generated in Phase One. Each of these seven items will be considered here, and suggestions made for how future MR courses might try to support staff with respect to that construct:

- ***Questionnaire Item 31 (relates to MR Principle 1)***

Teaches in enquiry based manner, with children thinking hard to solve challenging problems	V	***Teaches in a didactic manner, with teacher directly transmitting knowledge***

The constructs generated by staff in Phase One made no explicit references to problem-based or enquiry-based approaches. However, some of the examples which staff used in the interviews, when discussing specific activities and approaches that they used with children, were characteristic of enquiry-based teaching (e.g. leaving children lots of time to think, using what children do as the basis for setting the next task; as elaborated by Hatfield, 2001; Anghileri, 2006, Wright et al, 2006b). Perhaps the issue here is one of language: the staff may be developing their thinking along enquiry-based lines, but not well able to articulate this, because they are still using the language of the prevalent, National Curriculum-based teaching style. It would be helpful for staff to develop language in which to talk about enquiry-based teaching, as this could enable them to support each other more effectively, through sharing their developing ideas. In order to promote this, future MR courses might do the following:

- Ensure that the presentation of the MR course itself is done in a more enquiry-based, as opposed to didactic, manner, so as to model the approach.
  This could entail asking participants to engage with trying out and critically discussing their own ideas for assessing pupils' knowledge, before they are introduced to the Maths Recovery Interview Schedules. Also, one might use videotape examples of children at different stages, and ask participants to analyse and discuss the pupils' understanding. This would help the participants to construct their own understanding of the stages of children's development. Some such activities have already been developed and published by Munn (2006, in Wright et al, 2006c; Chapter 11 pp185 – 188).

- In tutorial sessions, ask course members to express verbally their reasons for choosing and structuring particular activities with pupils, and to draw out the problem-solving nature of what the pupils then do.

- In tutorial sessions, encourage staff to work together on selecting and designing activities for particular pupils, being explicit both about what mathematics is potentially prompted by the activity and about the process by which pupils will learn through the activity.

- *Questionnaire Item 19 (relates to MR Principle 2)*

Teacher assesses continuously through teaching, always revising their understanding of child's knowledge	V	***Teacher uses assessment in a static way, at fixed point in time and for summative purpose only***

Again, there were implicit references to ongoing assessment through teaching, in the interviewee constructs, and some examples were mentioned in the interviews. The procedure for delivering a Maths Recovery programme ensures that, after each taught lesson, the teacher reviews the pupil's performance on each task, and uses this to select the activities for the next lesson. This process, which is recorded on a linked series of planning sheets, ensures that assessment is ongoing throughout the programme. The author felt that it was not necessary to emphasise this process further, in future courses. However, it may be helpful to focus tutorial discussion more explicitly on the staff's understanding of the child's knowledge, before moving on to select the activity for the next lesson. Also, when using the questionnaire with future cohorts of staff, it will be important to check whether they do in fact rate themselves at the positive pole of this construct.

- *Questionnaire Item 4 (relates to Principle 3)*

Teaches just beyond the 'cutting edge' of each child's current knowledge	V	***Does not match teaching or tasks to child's performance***

The interviewees strongly emphasised differentiation, with a focus on selecting activities which would move the pupil on from where they currently were. However, the 'cutting edge' idea was not explicitly mentioned in any of the constructs which they generated. In order to focus more strongly on this, future MR courses might do the following:

- Include in the training more direct references to constructivist learning theory. In particular, it may be useful to include an activity which leads staff to reflect on what happens, at the physiological level of neural networks as well as at psychological levels, when new skills are learned. This will reinforce the idea that learning involves creating new pathways, and then actively linking them to previous networks.

Terhart (2003) distinguishes between four broad theoretical constructivist orientations (described in Chapter 2 above, p 26), one of which is the 'neurobiology of cognition'. He does not make explicit how knowledge about this neurobiology would help a teacher to develop a more constructivist approach. However, the theory is deeply reflexive in its nature: the brain is seen as constantly modifying its own structure, in a process of interacting with and accommodating to new information about the world. If teachers come to believe such a model of the brain, then they are likely to feel that they have power to affect how children understand the world, simply by presenting the children with the right data which they need, to help them to construct the next stage in their understanding.

There is indeed evidence to suggest that teacher beliefs about the nature of teaching and learning do influence their practice (Hoyles, 1991; Nisbet & Warren, 2000; Thompson, 1992). Finding effective ways of introducing teachers to these constructivist ideas, so that their beliefs and practices can develop in the light of them, is an ongoing challenge for this author, and for teacher educators more generally.

– In tutorials, when viewing tapes of lessons, ensure that discussion addresses whether staff are being sufficiently flexible about adjusting the activities in response to the pupil's performance, on a minute-by-minute basis.

- ***Questionnaire Item 21 (relates to Principle 5)***

Uses understanding of children's numerical strategies, to help them to develop more sophisticated ones	V	***Focuses on children getting correct answers: no interest in their strategies***

The idea of more sophisticated strategies was not mentioned by interviewees, although they did mention facilitating children's development, and helping them to extend the range of strategies which they use. The term 'more sophisticated', although it is used in Principle 5, is actually not well-defined in the MR literature: it seems to refer to strategies which are associated with a higher Stage of Early Arithmetic Learning (SEAL) (Wright et as, 2006b, p6). The current MR course already has a strong focus on staff attending to pupil strategies, and trying to move them on to a higher SEAL stage.

No steps to strengthen this are planned, but the questionnaire ratings on item 21 will help to show whether staff are developing in this aspect.

- ***Questionnaire Item 27 (relates to Principle 6)***

Makes intensive observations of pupils whilst teaching, and continually adjusts teaching on basis of these	V	***Disregards pupil responses, and keeps rigidly to a pre-planned course***

There were many staff constructs which related to this process of differentiating within a teaching session: the aspect which was not mentioned involved the relationship between the ongoing pupil observations and the continual adjusting of the planned session. To strengthen this, future MR courses might:

- Use tutorial time to discuss the next session to be taught, including discussion or role-play of what the teacher will do, if the pupil responds to tasks in various different ways.
- Encourage even more joint planning sessions between staff, where discussion about the next steps is based on viewing tapes of pupil responses.
- Encourage staff to be messier in their lesson planning sheets: these should be hand-written, rough notes of what will initially be tried, rather than a formal record of what was done. Some staff felt that, because the tutors were going to see these records, they should be neat and typed: this could have interfered with their flexibility of

response.

- *Questionnaire Item 14 (relates to Principle 7)*

Starts from child's intuitive, verbal strategies, and bases development of written methods on these	V	***Starts with direct teaching of standard, written methods***

The issue of how written methods are based on pupils' earlier strategies was not mentioned by the interviewees. This is probably due to two reasons. Firstly, the course asked staff to work with pupils in Year 1 (5-6 years old) who were having some difficulty with numeracy, and these pupils would not yet be expected to be using written calculation methods. Secondly, the MR programme itself has relatively little guidance and few activities to support the development of written methods. This might be addressed in future by:

– Ensuring that pupils who are struggling with the early stages of numeracy are noticed and offered well-targeted support to develop the intuitive, verbal strategies early on, before they are exposed to classroom teaching about written methods.

– Encouraging course members to refer to the National Curriculum expectations for written numeracy skills in Key Stage 1, and to consider how these might be approached within the Maths Recovery framework. This might involve extending some of the MR activities to include documenting the work, whilst ensuring that the teaching remains focused on developing relational understanding, and not written algorithms.

- Convening groups of staff to create new activities for use in MR programmes, designed to be used at each of the SEAL stages, which involve documenting the results of mental calculation, and developing written recording as a way of supporting and extending the power of mental calculation. (This sequence of recording results, then using larger numbers and 'informal jottings', long before any attempt to teach standard written methods, is the one which was adopted in the National Curriculum: see DfEE 1999, DfES 2001.) However, great care would need to be taken that written recording was not introduced too early, and that the intuitive, verbal strategies continued to be the central pillar of the programme.

- ***Questionnaire Item 8 (relates to Principle 9)***

Wants children to develop verification strategies, and to have intrinsic satisfaction from this	V	***Satisfied if children have just one method to solve a problem, and they get the right answer***

Verification methods were not mentioned, by the eleven interviewees. However, when the questionnaire was piloted with the group of 98 staff, this Item 8 was one which was nominated frequently (i.e. by 9 staff) as being the one on which they had improved the most. This highlights the potential usefulness of the questionnaire – which will be discussed further in 8.2.5 below.

In order further to develop staff thinking about verification, future courses could:

- In discussing the SEAL stages, draw attention to the greater range of strategies which pupils have at the higher stages.
- Try to prompt discussion of the role of the range of strategies, and of how this relates to the depth of understanding which the pupils have: the strategies need to be seen as indicators of aspects of the pupil's understanding, rather than as routes to answers to number tasks.

8.2.4 Aim 4: To evaluate the extent to which construct changes perceived by staff are associated with changes in their teaching practices, and hence possible changes for children

This aim was addressed through the inclusion of a question in the interviews, which directly asked staff about actual and intended changes to their teaching, made as a result of their involvement with Mathematics Recovery. These changes have been tabulated and discussed in Chapter 5 (Table 5.6 p149 and section 5.7 p148). It seems that staff were able, soon after completing the course, to implement changes to their own teaching practices. Such changes included the use of MR assessment methods in their classes, a shift in emphasis in their teaching towards problem-solving approaches, a reduction in the use of paper and pencil work with young children, an increase in the use of observation of what children do, the use of MR activities in whole class teaching, improved techniques for differentiation and the use of a more open style of verbal interaction with pupils. Some staff had also shared ideas from the course with colleagues.

Some staff could see other ways in which MR could be used more widely in their school, but had not yet been able to implement them. This depended on their role in the school, and on organisational and resource factors in the school. The ideas which were yet to be implemented included some plans for group work (which needed teaching time to be allocated to groups), use of MR assessments across the school (which needed staff time and policy changes in school), delivery of individual programmes (which needed staff time), use of MR in Special Needs assessments and Individual Education Plans (which needed the school Special Needs Coordinator to be informed about MR).

Overall, the MR training does seem to have been associated, for many of the staff involved, with an increasingly constructivist orientation towards their teaching, and with changes in their actual teaching practices.

8.2.5 Aim 5: to produce a tool (questionnaire) which staff in MR training can use to aid and review the development of their thinking about the teaching of number

In analysing the constructs which were generated by the staff interviews, a content analysis procedure was used (Jancowicz, 2004), with independent rating by a colleague being employed to enhance reliability. It was found that different interviewees had generated some similar constructs, which could be clustered into categories: the final analysis resulted in fifteen categories, with twenty-seven distinct Subthemes or Definitions within them. These twenty-seven Definitions, together with the seven new constructs described in 8.3.4 above, were used as the items in the questionnaire (given in Appendix L p315).

Initial piloting of the questionnaire confirmed its clarity and ease of use, and further piloting with a group of 98 staff was carried out, to begin to explore its use as a tool to aid and review the development of staff thinking about the teaching of number. The planned study ended at this point. The full pre and post course questionnaire results of individual staff were not available to the author. This was a deliberate choice, in order to respect confidentiality. However, there were also technical difficulties in collecting this information from some volunteers. It was felt to be very important that staff knew their results were confidential, and that they were able to take away their own data for future use.

From the pilot data which was successfully gathered, it seemed that staff found the questionnaire easy to use, and that several of them found it a useful aid to reflection. However, some staff found the manual scoring procedure difficult, and needed more time as well as further guidance on how to score and use the questionnaire. Because the questionnaires were completed during the first and last sessions of the course, it was also difficult to ensure confidentiality, especially between teachers and teaching assistants who worked in the same school.

It does seem to be difficult to find out whether staff use written feedback actively, to plan their development. This arose with the original eleven interviewees, where only two of them engaged in dialogue about their feedback. Whilst one cannot assume that the rest ignored the feedback, this does suggest that staff might need more structure and guidance, about how to use feedback. This is perhaps what one might expect, from the literature on teacher reflection: in order to develop through reflection, practitioners needs to focus on the relationship between thought and action in a specific social situation which they have experienced, and to allow this to influence future plans. This process of 'reflection-on-action' has been described as being, "a person's posterior analysis of his/her own actions" which "is an essential component of the learning process that constitutes professional training" (Garcia, Sanchez & Escudero, 2006). Various ways of prompting this reflection are described in the literature, including varieties of peer support and teacher training. It is not assumed that this reflection will just happen, in the absence of any guidance or support (Haggar, Burn, Mutton & Brindley, 2008).

It has therefore been decided, for future training courses, to present the questionnaire electronically, through the Internet, to be completed privately before and after the course sessions. The scores can then be automatically calculated, and given confidentially to course members as a printout, including scores from individual constructs and overall summary scores. The results will be accompanied by guidance on possible ways of using them to enhance future professional development, including prompts to discuss them with selected colleagues. This will potentially very much enrich the use of the questionnaire, making it a more powerful tool. Some draft ideas for the feedback and guidance sheets are included below, in Table 8.1.

The author had, initially, some concern that, by raising awareness of the complex issues involved in teaching numeracy, the course might actually cause teachers to notice areas where they need to develop, and therefore to view themselves more negatively. This did not happen: most staff viewed themselves as having been good teachers at the start of the course, and even better teachers at the end. They were also able to articulate ways in which they hoped to develop, in the future.

Table 8.1 Ideas for Guidance for using questionnaire & Results Feedback

1	Brief instructions for how to fill in the questionnaire. Possibly an option to print out a manual version of the questionnaire.
2	A list of the 34 constructs, with the positive pole on the left. Alongside each one, columns for the pre and post scores (transformed so that a low score is good) and the amount by which the score has changed for each construct.
3	A graphical representation of the information in 2 above, showing the pre and post scores on each construct as different coloured bars on a bar chart. This could be presented in three sections: constructs where the score has improved, constructs where it has got worse, and constructs where it has stayed the same.
4	<u>Suggestions for the use/interpretation of the data</u> a) Look at your pattern of responses. Which ones got better/worse (where a low score is good)? Do you agree that a low score would be good, on all of these? Do you agree that you have indeed changed in the way suggested by this data? b) Draw a Mind Map/concept diagram, or write a paragraph, describing yourself as a maths teacher. Do it again for 'the best maths teacher I could become'. c) Discuss your results and your diagram with a colleague. d) Share your map with the staff in your department. Can you develop a shared map, for the ideal teacher? Does it have implications for things you might do or develop, as a staff group? e) Use the work you have done in your Performance Management, to help you to plan your development and set appropriate targets. f) Do the questionnaire again, in 12 months time, and compare your results.

8.3 ISSUES ARISING FROM THE RESEARCH

The discussion above has centred on practical issues arising from running the interviews and developing the questionnaire, and on professional issues about the future use of the questionnaire. Future directions in developing the training course, in the light of the research findings, have been considered. There are also some wider issues which arose during the research, as well as some considerations about the suitability of the research methods which were used. The current section will discuss these.

8.3.1 The Author as Both Researcher and Trainer

In this study the author, who was researching the impact of the training upon staff constructs, was also one of the team of trainers. This raises an issue about the appropriateness of such a dual role, and the extent to which it may have affected the results.

In the tradition of positivist science, such a dual role would have been unacceptable, as it would be seen as compromising the objectivity of the data which was collected. However, the current study is of a different nature. The data was of a rather different character: it consisted of records of staff constructs which were collected through an interview process. The constructs were expressed verbally, and the words had to be negotiated between the researcher and the interviewee, so as both to encapsulate the interviewee's construct and to be accessible to the researcher (and to other users of the research). In this situation, the researcher's involvement in the training was actually very necessary: it meant that the interviewees and the researcher had shared vocabulary about the topic, and the interviewees were confident that the researcher would be able to empathise with them. It helped in the negotiation of shared meanings during the Personal Construct Psychology interviews. The researcher was actually an integral part of the research, participating in 'practitioner research' (Aubusson, 2007; Mistrano, 2008), which will be further discussed below.

On the other hand, when the questionnaire had been produced and was being piloted, the researcher/trainer role became potentially problematical. The main intention of the study was that the questionnaire should be used by the staff as a reflective tool, and the results would only be shared if the staff chose to do so. Some numerical data, including overall pre-course and post-course scores, was in fact collected, anonymously, and some attempt was made to analyse this data. (See chapter 7, sections 7.3.1 & 7.3.2 pp 184-195.) The status and interpretation of this data is an important issue, and will be addressed in section 8.3.2 below.

Rather than being in the positivist mould, the current research sits with the growing tradition of practitioner research. It recognises the interrelated nature of knowledge, the construction of knowledge by learners, and the process of supporting those learners. This is an increasingly popular stance (Lunenberg-Mieke, Ponte-Petra & van-de-Ven-Piet-Hein, 2007), and one which can work well in educational settings, because it ensures that the research results are relevant to practice, and are in a form where they can easily be applied. As Ruddock (1989) opines, teacher educators have a responsibility to help teachers engage in reflective research. In the current study, this responsibility is discharged by supporting the staff to reflect on their own practice, through the interviews and the use of the questionnaire as a reflective tool.

The methodology used in the current study highlights the need to harness staff's own perceptions of what they are learning, and to support them in refining and applying their understandings through a process of feedback and reflection. As Woolfolk says,

> "becoming a teacher should be seen as a continuing process, not something that magically occurs after courses are completed.......I would like to see more bridging research – more work on how teachers use the knowledge provided by educational psychologists...what meaning do they make of what they experience in our classes, and what do they do with it" (Woolfolk, in Shaughnessy, 2004, p162 and p175.)

8.3.2 Interpreting the data: Qualitative and Quantitative aspects

The numerical data from piloting the questionnaire with 69 staff were analysed in Chapter 7. The broad conclusions reached from this analysis were as follows. Firstly, there was indeed some change in overall scores between the precourse and the postcourse scores on the questionnaire. Secondly, neither the years of staff experience, nor their status as teacher or teaching assistant had a relationship to the amount of change which they made. However, these conclusions do not tell us much about what is actually going on for these staff. When the score of a staff member on an individual construct shifts, there are several possible reasons for this. The person may actually have changed their position on the construct. Alternatively, they may have developed a different understanding of the construct, so that comparing the two ratings is not very meaningful. Again, they may have changed their mind about where they were before the course relative to the construct, in effect 'rescaling' their thinking, so that the numerical shift becomes meaningless. In the light of these possibilities, it is clear that the numerical analysis, whilst it suggests that some kind of change to staff constructs took place, is unable to suggest the nature of that change.

However, the discussion in 8.2 above clearly shows how the aims of the study were well addressed through the qualitative aspects of the study, i.e. the content analysis of interview responses, and the use of the questionnaire as a reflective tool for staff in training. This study is primarily qualitative, with the quantitative results being used as a secondary source of information, less central to the aims of the study. In this respect, the study is might be seen as methodologically unusual: primarily qualitative studies often eschew quantitative analysis altogether, and primarily quantitative studies often use qualitative information only as a source of hypotheses (to be tested quantitatively) or for illustrative purposes (Freebody & Freiberg, 2006).

There is a strong argument that, in order to be useful to practitioners in the field of education, research needs to have a qualitative orientation.

Freebody and Freiberg (2006) suggest that research which is primarily quantitative, because it involves counting and measuring that which has previously been known to exist, cannot lead us to new phenomena, or even help us to see how an exciting new development which we might observe could be made to work in a different setting.

> "much (quantitative) research simply allows the fundamental, constitutive empirical bases of educational practice to escape.......we question whether quantitative researchers, or researchers using natural and social science methods, can discover phenomena that they did not already know to be there.....Merely methodological preferences actually come to reshape what counts as visible and legitimate educational practice." *(Freebody & Freiberg, 2006, p718)*

Thus, notwithstanding the attempt to illustrate shifts in staff constructs through statistical analysis of questionnaire scores, the important aspect of the current study is the constructs which staff donated, and the views about their own development which they formed and articulated when they used the questionnaires. This is quite difficult to capture and to transport across educational settings, and the questionnaire itself is offered as a tool for helping this to happen.

8.3.3 Teachers and Teaching Assistants

The staff involved in the current study, and those being trained in Mathematics Recovery within Cumbria, include both teachers and teaching assistants. It was not an aim of this study to research any differences between teachers and assistants in their response to the training. However, this issue arose quite often in the comments made by staff, and is worthy of comment here.

As is pointed out by Hancock & Eyres (2004), recent government policy in the UK has blurred the distinction between teachers and assistants, by creating 'higher level teaching assistants' who take roles traditionally done by teachers, and by funding teaching assistants to carry out literacy and numeracy group work with pupils who are falling behind. Ironically, it is this group of pupils which teachers have found hardest to teach effectively, and where one might therefore expect the most skilled and qualified teachers to be deployed. One might wonder whether teaching assistants would be able to benefit from a course such as Maths Recovery, or to understand and apply it sufficiently well. It is encouraging to note that the Cumbrian Maths Recovery training team have found that teaching assistants have a course completion rate which is similar to that of teachers, although the course completion rate cannot be equated with success in applying the course within the school context. One of the criteria used for course completion is that participants show, through video evidence, that they demonstrate a given list of skills and competencies. So we do know that the teaching assistants have shown the ability to apply the skills in a one-to-one context, during the course. There is also some evidence to suggest that the assistants have made conceptual changes, during the time in which they undertook the training: in the current study, the teaching assistants and the teachers were very similar in the degree to which they changed their constructions as a result of the course input. Further work might be done on this issue, by examining the results of pupils who received individual programmes taught by teachers or by teaching assistants. (However, it may be difficult to control for possible differences between the learning needs of the pupils who are taught by teachers or by teaching assistants: schools may well allocate pupils who are seen as having more complex needs to the teachers.) Once the electronic version of the questionnaire is running, it would also be feasible to look for differential response patterns between teachers and assistants, and to use this information to fine tune the support which is offered to staff in implementing MR in their schools.

8.3.4 Becoming More Constructivist

In Chapter 2 (section 2.3.4 p31) there was discussion of how a constructivist outlook has become the prevalent stance of mathematics educators, and of how Mathematics Recovery is firmly constructivist in its approach. In reviewing the changes which staff involved in this study made to their views about teaching and learning, evidence has emerged that they did tend to become more constructivist in their approach (see 8.2.1 and 8.2.4 above). However, there were significant gaps in the staff's adoption of the constructivist principles of MR. This is a key issue, and its implications will be discussed further here.

The current study has a strong focus on teaching staff's beliefs, as approached through the exploration of their construct systems using the methodology of Personal Construct Psychology. This contrasts with the focus which is often adopted in government documentation about the

National Curriculum (e.g. DfES 2001), where the approach is generally to identify some examples which are judged to be 'good teaching', then specify what practices and procedures comprise these, and encourage staff to adopt these practices. In such an approach, reflection is very much encouraged, but it will be focused on the degree to which the new practices have been adopted, and the perceived results of adopting them: the beliefs and constructs which emerge are treated very much as a side-effect, rather than as a core part of the development process.

Constructivist approaches, on the other hand, see beliefs as central to the process of staff development. (For example, Bereiter, 1994; Von Glasersfeld, 1994 & 1995.) Staff actions are seen as emerging from their construct systems/beliefs (which themselves have been shaped by reflecting on feedback from past actions). Because constructs and beliefs are driving the choice of actions, staff are able to plan for novel situations, and to respond flexibly, in a way which is not possible in a system which is driven by procedures. Staff are also likely to feel ownership of and confidence in the way they do things, because they have constructed it for themselves in response to their personal situation. As Schifter & Simon put it,

> "The core idea *(of constructivism)* is that, rather than passively absorbing or copying the understandings of others, learners must construct their own understandings............the learner must actively engage in problem situations in order to build understandings which are an extension of, and later become an integral part of, his or her cognitive web." *(Schifter & Simon, 1992, p188)*

It would, then, seem desirable to foster constructivism amongst mathematics teaching staff. Beswick, in discussing secondary school mathematics teachers' beliefs, comments that, "relatively little is known about the kinds of professional learning experiences that might be effective in engendering such beliefs" (Beswick, 2007, p117). Schifter et al (1992) also comment that new methods are needed to evaluate the impact of inservice experiences on teacher understandings and on changes in teaching.

The current study, which initially set out to explore changes in teacher understanding and practices following Mathematics Recovery training, has made a contribution to the above agenda. It has shown changes in both staff constructs and in their practices. More powerfully still, it has produced a tool (the questionnaire) which promises to enhance the effectiveness of future MR training in fostering constructivist teaching orientations. The supported use of such a questionnaire, particularly in its proposed electronic form, will significantly add to the range of professional learning experiences which is available.

8.3.5 Emotional Involvement

In working with the staff who participated in this study, the author was struck by the high level of emotional involvement which many of them appeared to have. This came through in some of the comments which they made during the interviews, in the body language they used, and in the fact that they generated several affective constructs – both about their own feelings, and about those of pupils (see section 5.5.1 p134). The emotions expressed were overwhelmingly positive, and were reflected in the overall satisfaction ratings which the cohort who piloted the questionnaire gave for the MR course. (The 102 course members gave it an average rating of 1.5, on a scale where 1 was the best possible score, and 5 the worst.) Where negative emotions were expressed, these were about the workload and associated stress, and were often linked to poor adherence by their schools to the pre-agreed arrangements for releasing staff time.

As with staff beliefs, staff emotions seem to be intimately connected to staff behaviours, and not merely a 'side-effect'. As Nias says,

> "The emotions are rooted in cognition.....one cannot separate feeling from perception, affectivity from judgement. It follows that one cannot help teachers develop their .....skills without also addressing their emotional reactions and responses and the attitudes, values and beliefs which underlie these." *(Nias, 1996, p294.)*

The literature about emotions suggests that they are linked to the person's cognitive appraisal of the meaning of ongoing events, and that positive emotions (e.g. happiness, satisfaction) are experienced when one is making progress towards a personal goal (Hargreaves, 1998; Lazarus, 1991; Sutton & Wheatley, 2003). Thus, engendering constructivist beliefs in teachers leads them to feel that they will be able to develop in response to ongoing experiences, and therefore are able to make progress towards their goals. This results in positive feelings. In the present study, it seems likely that, as the teachers were helped to reflect upon their increased constructivist outlook, they became more aware of the progress they could make. This led to a 'cycle of optimism', with associated positive feelings. This process was most striking for Interviewee 6 (as described in Chapter 5, table 5.2 p127), who had used the MR training to help him reconstruct his positive feelings about himself as a teacher, following a difficult period in his life. There are illustrations of this happening with other Interviewees, for example when Interviewee 5 says, "Before, I could see when children were getting stuck, but I didn't necessarily know what to do about it. Now, I know that, even if their difficulty is something new to me, I am going to be able to help them resolve it....I'm much more confident." Another example is when Interviewee 10, who is a teaching assistant, says, " I would just keep quiet when it came to planning, 'cos I'm not a teacher....and that made me feel ...sort of less......:But now I feel I can join in with the planning, and what I think does count....I'm more a part of the team, and I like that."

As a result of this consideration of the role of emotional involvement in staff development, it would seem important to give staff emotions a central role, when planning in-service work. (Nias, 1996) Rather than trying directly to teach specific practices or procedures, and hoping that the success of these will lead to positive emotions, staff trainers need to structure their work in a different (more constructivist) way:

- First, aim to develop staff's understanding of principles and constructs.

- Support staff to experiment with the consequences for their practice of implementing their new constructs.

- Attend to the emotions which staff experience. Initially, they are likely to find it emotionally difficult to make changes in their practice. (Hodgen & Askew, 2007). However, as they successfully implement the new practices, they should feel increasingly positive. If they do not, they may be merely copying behavioural models, rather than developing their own, coherent set of constructs.

8.4 FUTURE RESEARCH

The study suggests some areas for further investigation. One such area is the practical implementation of the ideas generated, to improve the impact of future Maths Recovery courses, and the monitoring of the effectiveness of this. This suggestion has been explored in detail in section 8.2 above, through suggestions for enhanced use of tutorial time, and for further developing the use of the questionnaire.

Another area for further research would be in looking more precisely at how it might be possible to promote the development of constructivist thinking by teaching staff. The current study has demonstrated that, although staff did become more constructivist in their orientation when they engaged with the Maths Recovery course, they also had difficulty in assimilating some of the constructivist principles of MR. The study has not shown exactly what about their experiences brought about this shift. Neither has it explored what conditions or forms of support are needed in their schools, for this process of development to continue. This is, of course, a vast question. However, a focussed, qualitative study of how a small number of teachers develop, within the specific environments of their own schools, when they try to apply the Maths Recovery approach could make a contribution to knowledge in this area.

One approach might be to start with the seven extra questionnaire items (derived from the MR Principles, and given in 8.2.3 above) which were added to the questionnaire because they had not been generated by the original interviewees. One might work with staff who rate themselves as having improved on these items, and ask them what experiences they believe to have led to (or to have worked against) this improvement.

Another, wider approach would be to use PCP grids to study longitudinally the development of some mathematics teachers. By using a donated construct such as "a constuctivist teacher V a transmission-based teacher", the researcher might engage in productive dialogue about the strengths and difficulties of constructivist approaches in the classroom.

8.5 CONCLUDING COMMENTS

The main aims of the current study, as outlined in Chapter 3 (section 3.1 p72) have largely been met. Personal Construct Psychology methods were used to explore staff constructs about the teaching and learning of number. It was indeed possible, through individual PCP interviews, to find out how staff perceived their constructs to have changed, after they completed a programme of Mathematics Recovery training. An attempt was made, using the questionnaire which was developed in the course of the study, to look at how the constructs of a larger group of staff changed after MR training. This proved more problematical, because of difficulties in satisfactorily administering, scoring and discussing results with the participants. A method of improving this situation, through the use of an electronically administered version of the questionnaire, has been proposed.

A comparison was made between the Principles of Mathematics Recovery and the construct systems of the trained staff. It was found that many of the staff constructs did reflect the Principles, but there were some gaps, as well as some important staff constructs which were outside of the range of the Mathematics Recovery Principles. Items about the gaps were included in the questionnaire which was produced, and suggestions have been made about how to improve future courses, so as to focus on the gaps. The questionnaire can be used, for future courses, to assess the success of these suggestions.

It was found that staff did change their teaching practices, in line with the Principles of Mathematics Recovery. Some changes which they wished to make were hard to implement, for organisational and financial reasons.

A key finding was that, although there was some evidence of staff becoming more constructivist in their beliefs about teaching, the staff found this very difficult to articulate. They were more likely to respond to a questionnaire item by rating themselves as having become more constructivist, than they were to express this shift in their own words. However, most of the staff showed an increased confidence in themselves as good teachers of numeracy, and believed that they were capable of improving still further.

Reflecting on the outcomes of this study has led the author to the view that the delivery of the course itself needs to be more constructivist (and less directive) in its nature, in order to promote the desired conceptual shift in the staff who participate in it. The study has made a useful contribution to the evaluation of the training of staff in Maths Recovery, and the questionnaire which has been produced could well have a wider applicability, in helping staff to reflect upon the development of their numeracy teaching.

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APPENDIX A

SUMMARY OF GEORGE KELLY'S POSTULATE AND COROLLARIES

FUNDAMENTAL POSTULATE
A person's processes are psychologically channelized by the ways in which he anticipates events.

Construction corollary
A person anticipates events by construing their replications.

Individuality Corollary
Persons differ from each other in their construction of events.

Organisation Corollary
Each person characteristically evolves, for his convenience in anticipating events, a construction system embracing ordinal relationships between constructs.

Dichotomy Corollary
A person's construction system is composed of a finite number of dichotomous constructs.

Choice Corollary
A person chooses for himself that alternative in a dichotomised construct through which he anticipates the greater possibility for extension and definition of his system.

Range Corollary
A construct is convenient for the anticipation of a finite range of events only.

Experience Corollary
A person's construction system varies as he successively construes the replications of events.

Modulation Corollary
The variation in a person's construction system is limited by the permeability of the constructs within whose ranges of convenience the variants lie.

Fragmentation Corollary
A person may successively employ a variety of construction subsystems which are inferentially incompatible with each other.

Commonality Corollary
To the extent that one person employs a construction of experience which is similar to that employed by another, his psychological processes are similar to those of the other person.

Sociality Corollary
To the extent that one person construes the construction processes of another he may play a role in a social process involving he other person.

Adapted from Kelly, 1955/1991.

APPENDIX B

PCP INTERVIEW ON THE TEACHING OF NUMBER:
Schedule for interview

1) Introduction:
   - **a** Check timing (about 1 hour), conditions, freedom from interruptions.
   - **b** Reminder of purpose and structure of study.
   - **c** Recording of interview: purpose, to help me analyse. Confidentiality, destroyed at end. Check agreement.
   - **d** Brief description of nature of grid interview:
     - structured interview; series of comparisons
     - seeking interviewee's own views, not 'right' answers;
     - level of detail chosen by interviewee; discuss possibility of core constructs, and interviewee freedom to engage as deeply as wished
     - opportunity to receive & discuss feedback (written, telephone or personal)
     - confidentiality of individual responses, and anonymity in write-up.

2) Main Steps of Interview:
   - **a** Present and clarify the Topic, and Qualifying Phrase

   - **b** Agree the Elements, and get interviewee to write these on 8 cards.

   - **c** Triadic elicitation of constructs:
     'which two of these are alike in some way, and different from the third?
     Move the cards, to reflect this.

   - ***d*** Elicit emergent pole of construct:
     'What do these two have in common, as opposed to this one?'

   - **e** Elicit implicit/contrast pole:
     negotiate words that make sense to both, and interviewee agrees encapsulate intended meaning.

   - **f** CHECK level of construct: is it suited to the purpose of the grid? If not, or if the interviewee is 'stuck', consider following strategies:
     - Abandon the triad
     - 'Laddering' downwards/upwards – see prompt notes. Record on Interview Notes sheet.
     - 'Pyramiding' – see prompt notes, and record on Interview Notes sheet.
     - If really stuck, consider using 'character sketch' method of elicitation instead: see prompt notes.

   - **g** Rating scale: get the interviewee to rate each of the elements on the construct, using a scale of 1 to 7. Start with the triad, then the other elements. (It may be helpful to rank order the element cards, to help do this.) 1 is emergent pole, 7 is implicit pole.

h Continue steps **c** to **g**, until constructs are becoming repetitive, or enough (about 7 to 8) are elicited, or time runs out. NB the 'laddering' may provide constructs, rendering future triads unnecessary.

i Overall Summary construct: explain this, and get interviewee to rate the elements on it.

j Ask interviewee to consider the relative importance of the elicited constructs, for them as a teacher. Rank order them, then say which are 'core' and which are 'peripheral'.
'Some of these constructs may have a deep, personal significance for you. These, which we call Core Constructs, really matter to you, and are important for your sense of self. Please put these construct in order, according to how close to the core they are, for you.... *1 core, high nos are peripheral..............* ***now put a ring around the ones which are 'core' for you'***
Record this sequence, on Interview Notes sheet.

k Ask interviewee about changes to their practice, following the MR training:
'Following your Maths Recovery training, did you make any changes to your teaching?.......are you intending to make any changes?'
Explore responses, and record on Interview Notes sheet.

3) Conclusion of Interview:
a Clarify any questions, deal with any concerns.
b Remind of arrangements for follow-up interview, including opportunity for feedback on analysis.
c Thank interviewee.

APPENDIX C

INTERVIEW NOTES: PCP Interview on Teaching of Number

Interviewee.......................... School..........................
Date..............

- Eliciting constructs (Laddering/Pyramiding/Character Sketch)

-

- Core/Peripheral information:

- Changes to Practice (actual & intended)

- Other points

APPENDIX D

PCP INTERVIEW ON THE TEACHING OF NUMBER: PROMPT NOTES

- **Laddering Down**
  Use laddering down, if construct is too general/global:

    - Ask a HOW question, about emergent pole:
      What kind of person is like that?
      In what particular way?
      Can you give me an example of what you mean?
      Write down, beneath emergent pole.

    - Ask HOW about implicit pole, and write answer down beneath implicit pole.

    - Repeat as needed, until suitable construct emerges.

- **Laddering Up**
  Use laddering up, if construct is too specific, and you want to arrive at a more superordinate/core construct/value:

    - Ask which end of the construct the person prefers/which feels good to them.
    - Ask why they prefer that pole (Why is this important for you/what follows for you, from that choice?....) write this new construct down above the first one.
    - Elicit opposite pole of the new construct, and ask which ple is preferred.
    - Repeat , until desired level is reached.

- **Pyramiding**
  Use to extend the variety/range of constructs:

    - Ask a HOW question, about emergent pole.
      Write answer down, below emergent pole.

    - Ask for the opposite pole, and write down alongside.

    - Ask HOW about opposite pole of original construct

    - Ask for opposite pole of this, and write down alongside.

    - STOP – or repeat HOW about the 4 constructs you have.

- **Character Sketch**
  Use this if elicitation through elements is not working, and interviewee is getting stuck:

- 'Imagine you are a pupil you work with, and who really highly values working with you. Write a 'pen portrait' of how this pupil would describe you, as a teacher of number.'

- Discuss the sketch, and draw constructs from this.

APPENDIX E

TOPIC: **The Teaching of Number**

QUALIFYING PHRASE: **How staff help children to learn: the approach they take, and what they do**

	1 Me when new to teaching	2 Me just before MR training	3 Me now	4 The best teacher I could be	5 A teacher I disliked	6 My best teacher	7 Professionally respected colleague	8 Colleague I disagree with	
1									
2									
3									
4									
5									
6									
7									
8									
9 Teaches numeracy very well									Teaches numeracy very poorly

Name.. **No**........**School**...............................

Date.................**Date MR training completed**.................**Teacher/TA**..........

APPENDIX E

TOPIC: **The Teaching of Number**

QUALIFYING PHRASE: **How staff help children to learn: the approach they take, and what they do**

← Rank order

Rank	Construct	1 Me when new to teaching	2 Me just before MR training	3 Me now	4 The best teacher I could be	5 A teacher I disliked	6 My best teacher	7 Professionally respected colleague	8 Colleague I disagree with	Contrast
1	3.1 Empathises with child 1	4	3	1	1	5	3	1	3	Dictates to child — tells them what to do.
		2	3	5	5	1	3	5	3	
8	3.2 8,5. 7 Motivates by fear — gets cross.	3	5	5	5	1	4	5	~~8~~ 3	Makes work fun so child wants to learn
		3	1	1	1	5	2	1	3	
6	3.3 8&1 vs 4 Willing to change	1	1	1	1	5	2	1	4	Inflexible, clings to old methods
		5	5	5	5	1	4	5	1	
7	3.4 8&1 vs 4, ~~Inexperienced~~, naive about teaching	1	4	3	5	5	5	5	3	~~Experienced~~, Knowledge & skilled in the classroom
		5	2	3	1	1	1	1	3	
4	3.5 8&1 v 4 Plans & reflects on teaching.	1	1	1	1	4	1	1	4	Disenchanted — doesn't reflect on teaching.
		5	5	5	5	2	5	5	2	
5	3.6 8&4. vs 3 Dedicated to the job	2	1	1	1	3	1	1	1	Not bothered about the job — a slacker.
		4	5	5	5	3	5	5	5	
2	3.7 Patient: is positive & calm, doesn't rush children.	3	2	2	1	5	3	1	4	Impatient: flustered & cross
		3	4	4	5	1	3	5	2	
3	3.8 Presents a ~~problem~~ task and gives children space to attempt it.	4	3	1	1	5	4	2	5	Presents a task and tells children how to solve it.
		2	3	5	5	1	2	4	1	
	3.9 Teaches numeracy very well	4	3	1	1	4	2	3	3	Teaches numeracy very poorly

Name PC. No 3 School Individual Tutor.

Date 29. Date MR training completed Spring. Teacher/TA

Years experience: 23.

Initial Individual Grid Analysis Sheet

Interviewee..7.....(CL)............................ Date...05 12 05.........

Process analysis and Eyeball Analysis
Topic *(reaction)*

The interviewee engaged deeply with the topic, choosing to reflect on specific events from her past, and to 'think aloud' about how these now fit into her view of teaching.

Elements *(ease of identification ,relevance to topic)*
She found it hard to identify negative elements (5 & 8), but all elements were found to be relevant to the constructs being considered.

Constructs ***(qualifying phrase, novel or difficult constructs, type & nature of constructs (prepositional/constellatory;pre-emptive;affective;behavioural;evaluative;attributional)……how much time/effort did it take to elicit them?***
Large range of construct types – first few were behavioural (1, 3, 4), but others were attributional (6, 8)
Took time to elicit, but triads were helpful in generating new ideas, and in generating value-laden/higher order constructs. laddering down used (construct 7) & ladder down (5).

Found it quite hard to generate these constructs – took time to reflect, & then articulate her ideas.

Ratings (Easy or hard? Meaningful task? Range of convenience? Emotional involvement?………how is range of ratings used/ What is being said about each element/contruct?)

Generally found it fairly easy to rate elements, except for those with self (1, 2, 3), which took longer to decide.
Full range of ratings used for most constructs.
Ratings show that most constructs are used evaluatively – each one has a strongly positive and a strongly negative pole – except for construct 4 ('encourages child talk & activity') and 5 (knows what she wants children to learn, & designs structures to lead them). These 2 constructs get mid-range ratings for 'the best teacher I could be.' (Is this reflecting her ideal of good teaching or her confidence that she could become this?)

***Supplied Elements & Constructs** (How are the different 'self' elements rated? How do these relate to the overall construct?)*

Difficulty in rating 'self' elements.
Significant shift between 'Me now' 3 & 'just before MR' 2 (on 4 of the 9 constructs) so from 'just before MR' 2 to 'when new to teaching' (on 6 of the 9 constructs). These two shifts were in same direction — ~~suggests~~ looking at 'teaches numeracy very well' 9 suggests interviewee thinks ~~had~~ her numeracy teaching has improved across her 27 yrs of teaching — with significant improvements in the 2½ yrs since MR training was started.

~~fed~~ back on paper; Jun 08.

***Conclusions/Hypotheses/interpretations** (to be/have been discussed with interviewee)*

- MR ~~teaching~~ experience has improved my teaching — on constructs 1, 2, 3,

- She is now v. close to as good as she can be — further improvement could happen in 'set & maintain behavioural standards' 7 in class (as she is out of practice, because takes mainly 1-1 now), and in 'enthusiastic about the subject' 8 (which is rated high, but not a 1).

-

APPENDIX G

G(1)	Analysis of Individual Grid: Interviewee No. 1
G(2)	Analysis of Individual Grid: Interviewee No. 2
G(3)	Analysis of Individual Grid: Interviewee No. 3
G(4)	Analysis of Individual Grid: Interviewee No. 4
G(5)	Analysis of Individual Grid: Interviewee No. 5
G(6)	Analysis of Individual Grid: Interviewee No. 6
G(7)	Analysis of Individual Grid: Interviewee No. 7
G(8)	Analysis of Individual Grid: Interviewee No. 8
G(9)	Analysis of Individual Grid: Interviewee No. 9
G(10)	Analysis of Individual Grid: Interviewee No. 10
G(11)	Analysis of Individual Grid: Interviewee No. 11

APPENDIX G(1)
ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 1** **Date:**

Constructs

1	Works out of safe zone: challenges philosophy & beliefs	◄──►	Always works the same way, sticks with what they know best
2	Confident	◄──►	Insecure
3	Tries to give children their absolute best	◄──►	Bone idle – just in the job for the pension!
4	Does inspirational teaching	◄──►	Doesn't understand what is good practice
5	Enthuses children to develop their own learning	◄──►	Motivates children through negative/punitive means
6	Very good subject knowledge	◄──►	Very poor subject knowledge
7	Has secure belief in their philosophy of teaching	◄──►	Has confused beliefs/philosophy of teaching
8	Facilitates and inspires confidence in others	◄──►	Dictator – tells others what to do
9	Teaches numeracy very well	◄──►	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns); *CONSTRUCTS REVERSED* (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		2	2	3	1	5	6	6	1
2	22		2	1	1	3	4	4	1
3	22	21		3	3	3	4	4	3
4	21	20	21		2	4	5	5	2
5	22	21	21	20		4	5	5	0
6	19	18	19	18	18		1	5	4
7	18	19	18	19	19	21		6	5
8	18	17	18	17	17	15	16		5
9	21	20	21	20	20	18	19	17	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		7	8	17	19	8	13	17
2	Me just before MR training			1	10	23	1	6	18
3	Me now				9	24	0	6	19
4	The best teacher I could be					33	9	3	28
5	A teacher I disliked						24	30	9
6	My best teacher							6	19
7	Professionally respected colleague								26
8	Colleague I disagree with								

APPENDIX G(1) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 1 Date:

The interviewee was very interested in the topic, which she says forms an important part of her work. She has previously thought deeply about Maths Recovery and teaching and learning, so her constructs are clearly articulated, and the relationships between them are consistent and quite strong. Where the positive poles of two constructs are highly related, the negative poles are also strongly related.

Constructs 1,2,3,4,5 & 9 are closely related, and correlate with the donated construct, 'teaches numeracy very well' (9). A picture emerges of the good teacher of numeracy, who works hard (3) and with confidence (2), seeking to inspire (4) pupils and to motivate them to develop their own learning (5). This teacher is willing to take risks (1), in order to develop such inspirational teaching (4).

Constructs 6 & 7 are also closely related, i.e. having good subject knowledge goes with having a secure belief in one's philosophy of teaching.

The interviewee perceives herself as very similar indeed to her 'best teacher' (6), and also similar to 'professionally respected colleague' (7), and feels that she is now more like this respected colleague than she was as a new teacher.

The grid suggests that her views did not change much as a consequence of undergoing Maths Recovery training. ('Me just before training' (2) and 'me now' (3) receive almost identical ratings.) However, discussion with the interviewee reveals more. She talks about a new construct:

Breaks work down and goes back to first principles	⟷	Tries to plug the gaps in pupils' knowledge

She says this is an important construct for her, and that she has moved further towards the left hand (positive) pole of it, as a consequence of the training and of her subsequent work with Maths Recovery.

She also explained the apparently minimal shift in other constructs, following the training. She had been responsible for researching and choosing Maths Recovery as an approach for the local authority to adopt. This meant that she chose it partly because it matched her own existing beliefs about good teaching. It is thus not surprising that there were no major shifts in her thinking, on the constructs which were explored.

APPENDIX G(2)
ANALYSIS OF INDIVIDUAL GRID Interviewee No: 2 Date: 22.09.05

Constructs

1	Committed to the job	◄──►	Marking time, underperforming
2	Enjoys the job	◄──►	Totally disillusioned
3	Knows how children learn number	◄──►	No knowledge of how they learn number
4	Good behaviour management	◄──►	Poor behaviour management
5	Structures their teaching	◄──►	Haphazard approach to teaching
6	Wants children to enjoy maths	◄──►	Indifference to children's enjoyment
7	Provides work to stretch each child	◄──►	No differentiation in work provided
8	Promotes independent learning	◄──►	Spoon-feeds children
9	Teaches numeracy very well	◄──►	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns); *CONSTRUCTS REVERSED* (rows)

	1	2	3	4	5	6	7	8	9
1		2	6	6	5	2	6	5	3
2	20		6	8	7	4	7	6	5
3	22	20		4	7	4	5	4	3
4	24	22	26		7	4	5	4	5
5	25	23	21	23		7	2	5	4
6	22	20	22	26	23		5	4	3
7	23	21	21	25	26	21		3	2
8	22	20	22	26	23	22	21		3
9	21	19	21	25	24	21	22	21	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	2	3	4	5	6	7	8
1	Me when new to teaching		23	28	28	11	26	26	12
2	Me just before MR training			5	5	18	5	5	15
3	Me now				0	21	2	2	20
4	The best teacher I could be					21	2	2	20
5	A teacher I disliked						19	19	13
6	My best teacher							2	18
7	Professionally respected colleague								18
8	Colleague I disagree with								

APPENDIX G(2) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 2 Date:

The interviewee was keen to discuss the topic, and often explicitly focused on how she had changed since Maths Recovery training, during the interview. At times, she generated constructs directly through reflecting on this change, rather than through comparisons between the elements. She found it hard to think of negative/disliked elements (8 & 5), and always generated the preferred (positive) pole of each construct first.

A group of the constructs are tightly clustered around the donated construct 'teaches numeracy very well (9)', with all the elements being rated similarly on all of the constructs in this group. This group includes 'committed to the job (1)', 'knows how children learn number (3)', 'wants children to enjoy maths (6)', 'provides work to stretch each child (7)' and 'promotes independent learning (8)'. A picture emerges of a good numeracy teacher, who is very committed, knows how children learn, and uses this knowledge to individualise work tasks, so that each child will learn effectively. The grid also shows that 'committed to the job (1)' is closely related to 'enjoys the job (2)', and that 'structures their teaching (5)' is closely related to 'provides work to stretch each child (7)'.

Looking at the relationships between reversed constructs, we see that construct 4, 'good behaviour management', is also related to 'teaches numeracy very well (9)'. The interviewee sees 'poor behaviour management' as being unlikely to accompany 'good numeracy teaching (9)' or 'commitment to the job (1)', or 'knowing how children learn number (3)'.

When the interviewee was asked to say which of her constructs were most important for good teaching, and which were less central, she was unable to do this: for her, they all interact to make an essential contribution to the good teaching of number.

The interviewee rates herself now (3) as very similar to 'the best teacher I could be (4)', and close to 'my best teacher (6)' and to 'professionally respected colleague (7)'. She explains this by saying that, because she has vast experience and much training, she must by now be approaching the best she can ever be. In contrast, she rates 'me when new to teaching (1)' quite negatively, and perceives it as very different from 'me now (3)' and 'the best teacher I could be (4)'.

In discussion, she is very articulate about how Maths recovery training has changed her view of learning and teaching. She highlights:

- The importance of oral and visual work, rather than pencil and paper, in the early years
- The importance of asking pupils what they see, rather than telling them what you want them to see (which relates to construct 8).

She explains how she has changed her practice on a number of levels, including:

- Wider range of activities and equipment used in whole class work

- Better differentiation of tasks and questions, in whole class, group and individual work
- Use of structure to analyse next steps for lower-achieving pupils
- Well developed use of assessments to monitor school performance, and to track individual pupil progress, especially in Y1
- Changes to her style of questioning – more open, and making better use of pupil answers
- Different, more varied approach to teaching counting sequences – both backwards and forwards, starting at different places, even with young children.

She has future plans, to develop the use of the teaching activities in the Y1 classroom, in small-group withdrawal work, and in pupils' Individual Education Plans. Because of her role as the school's subject leader in maths, she is planning how to share her insights with other staff.

APPENDIX G(3)

ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 3** **Date:**

Constructs

1	Empathises with child	◄——►	Dictates to child – tells them what to do
2	Motivates by fear – gets cross	◄——►	Makes work fun so child wants to learn
3	Willing to change	◄——►	Inflexible – clings to old methods
4	Naive about teaching	◄——►	Knowledgeable & skilled in the classroom
5	Plans & reflects on teaching	◄——►	Disenchanted – doesn't reflect on teaching
6	Dedicated to the job	◄——►	Not bothered about the job – a slacker
7	Patient: is positive and calm, doesn't rush children	◄——►	Impatient: flustered, cross
8	Present task & gives children space to attempt it	◄——►	Presents task & tells children how to solve it
9	Teaches numeracy very well	◄——►	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns) / *CONSTRUCTS REVERSED* (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		20	7	16	9	10	4	4	4
2	4		25	10	25	24	20	20	18
3	21	3		17	2	7	5	9	9
4	10	18	14		19	22	16	16	16
5	21	5	29	11		5	7	11	9
6	20	6	26	10	25		10	14	10
7	18	4	24	10	23	20		6	8
8	20	8	22	22	21	16	20		6
9	16	6	20	10	19	18	16	16	

Similarities Between Elements

Figures are 'simple differences', range 0 to 36. High and low values highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		10	15	18	18	10	15	13
2	Me just before MR training			7	8	22	6	5	13
3	Me now				3	29	11	7	18
4	The best teacher I could be					28	10	3	14
5	A teacher I disliked						18	25	11
6	My best teacher							9	11
7	Professionally respected colleague								18
8	Colleague I disagree with								

APPENDIX G(3) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 3 Date:

The interviewee, as part of her professional development, had recently reflected on and written about the effects Maths Recovery has had on her, so she readily engaged with the interview topic. She found the use of triads of elements quite helpful, and would sometimes produce quite a loose, general idea from a triad: use of 'laddering down' would produce several distinct, more precise constructs. (e.g. constructs 3,4 & 5 emerged from the more general idea of being 'well-intentioned'.)

The overall summary construct, 'teaches numeracy very well' (9) is closely related to 'empathises with child (1), and 'presents task & gives child space to attempt it'(8). Another construct, 'patient: positive & calm, doesn't rush children' (7) also generates similar ratings to this group. A pair of constructs, 'plans & reflects on teaching' (5) and 'willing to change' (3) generate almost identical ratings, and are positively regarded. Construct 6, 'dedicated to the job', is also closely related to this pair. Thus, there is a cluster of constructs, 1,8,7,3,5 & 6, the positive poles of which are associated with the overall summary construct, 'teaches numeracy very well'. Construct 2, 'motivates by fear, gets cross', is negatively related to this cluster.

This gives a picture of the good numeracy teacher as a dedicated person, who empathises with the child. Rather than telling children what to do, this teacher sets tasks and patiently gives children opportunities to solve them. This teacher wants children to be self-motivated through enjoying the work. She is reflective about her teaching, and changes her practice accordingly.

Looking at the elements in the grid, 'me just before training' (2) is rated similarly to 'my best teacher' (6) and 'respected colleague' (7). 'Me now' (3) is still close to 6 & 7, but has moved since Maths Recovery training so as to be still closer to 'the best teacher I could be' (4). Looking at the ratings on the original grid, changes that have occurred involve giving children more space to attempt tasks, becoming more knowledgeable and skilled in the classroom, and empathising more with the child.

It seems that the interviewee has always, right from the start of her teaching career, been dedicated, reflective and willing to change. She thinks that before Maths Recovery training, she was similar to 'respected colleague'(7) and 'my best teacher' (6). (Perhaps she had modelled aspects of her teaching on theirs?) After the training, she feels she has moved closer to her ideal ('the best teacher I could be'), having gained confidence to be less directive and more a facilitator of children's problem-solving.

She describes important changes which she has made in her practice, since Maths Recovery training:

APPENDIX G(3) (contd)

- She now sits back, waits and watches what children are doing, rather than rushing in quickly to help.
- She is more confident to teach unfamiliar curricular areas (which her role as an individual tutor of sick children often demands), because she knows how to work with what they already know and to help them to extend this, rather than to try to transmit knowledge didactically.
- From watching video tape of her teaching, she has become more aware of her own body language, and now tries to minimise mannerisms which could disrupt the child's concentration.
- In planning for individual pupils, she now makes more use of ongoing assessment, to ensure she is teaching in the pupil's 'Zone of Next Development', i.e. just beyond what they can already do independently.

APPENDIX G(4)

ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 4** **Date:**

Constructs

1	Values people for what they are: not prejudiced	◄────►	Prejudiced: no attempt to empathise with others
2	Starts from where children are	◄────►	Starts from where they think children should be
3	Structures lessons well, & makes this clear to pupils	◄────►	Looks disorganised, to an observer
4	Rigid, inflexible: set ways of doing things	◄────►	Relaxed approach, flexible
5	In-depth knowledge of number	◄────►	No knowledge of number
6	Great understanding of teaching number	◄────►	No understanding of teaching number
7	Interacts to draw things from pupils	◄────►	'chalk & talk'
8	Wants children to enjoy the subject & want to learn more	◄────►	Just comes to work for the monthly payslip
9	Teaches numeracy very well	◄────►	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns) / ***CONSTRUCTS REVERSED*** (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		9	5	20	8	16	4	4	9
2	19		6	12	7	7	5	11	4
3	23	16		16	9	13	7	7	10
4	7	8	8		11	12	17	23	12
5	16	9	13	13		8	6	12	5
6	12	9	11	13	8		12	18	7
7	22	15	19	7	12	8		8	5
8	28	19	23	9	18	12	24		13
9	17	10	14	9	11	11	13	19	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		2	7	9	15	10	8	6
2	Me just before MR training			5	7	17	8	6	8
3	Me now				4	20	9	5	13
4	The best teacher I could be					24	7	3	13
5	A teacher I disliked						21	21	13
6	My best teacher							4	12
7	Professionally respected colleague								10
8	Colleague I disagree with								

APPENDIX G(4) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 4 Date:

The interviewee readily engaged with the topic, as she is used to reflecting on her practice, and recognises the need to articulate what she thinks is good practice, because of her role as an advisory teacher. However, she said that she is not a naturally verbal thinker, and she found the interview process quite difficult. Often, constructs were generated in quite vague or general terms, and 'laddering down' was used, to reach a more precise construct, and to ensure that the words used did in fact encapsulate her idea. She found it hard to use triadic elicitation (three cards), and easier to use just two cards, generating a way in which they were similar. At the end of the interview, she finds it hard to say which of her constructs are most important for 'good teaching of numeracy', as she believes they are all important, perhaps with constructs 1 & 5 being a bit less central than the others.

There is a fairly tight cluster of constructs, which are closely related to the overall construct 'teaches numeracy very well'(9). This includes construct 2, 'starts from where children are', which generates similar ratings to 'structures lessons well'(3), 'in-depth knowledge of number'(5), 'great understanding of teaching number'(6) and 'interacts to draw things from pupils'(7). Construct 1, 'values people for what they are', is also part of this cluster, and links strongly to 'wants children to enjoy the subject and want to learn more'(8). Construct 4, 'rigid, inflexible: set ways of doing things' , is negatively related to this cluster, and has particularly strong negative relationships with 'values people for what they are'(1) and with 'interacts to draw things from pupils'(7).

The picture of a good numeracy teacher which emerges is of one who values all pupils for what they are, and therefore aims the teaching at where each individual pupil currently is. She does this through clearly structured lessons, with much interaction with the pupils. She has good understanding of how to teach number, and also good knowledge of number. She wants the children to become self-motivated, through their enjoyment of the subject. She takes a flexible and relaxed approach, avoiding 'chalk & talk' and attempting to empathise with pupils.

Looking at the relationships between elements, one sees a cluster of elements which are rated similarly: 'me now'(3), 'me just before MR training'(2), 'the best teacher I could be'(4) and 'professionally respected colleague'(7). 'Professionally respected colleague'(7) is also similar to 'my best teacher'(6). 'Me when new to teaching'(1) is rated very similarly to 'me just before MR training'(2), and is also quite similar to 'colleague I disagree with'(8). The element 'teacher I disliked'(5) received generally quite high scores, showing it is rated dissimilarly to the other elements: it is particularly unlike 'the best teacher I could be'(4).

APPENDIX G(4) (contd)

The interviewee has a positive view of herself as a numeracy teacher, both before and after Maths Recovery training. She feels that she has improved somewhat since the MR training, in that she is better at starting from where children are (2), understanding the teaching of number (6), structuring lessons(3) and being flexible (4). She perceives more change in herself, with respect to the constructs she has identified, in the two years since her Maths Recovery training than in the 16 years since she began teaching.

The interviewee has made several changes to her practice, since the training. She has also recently changed her job, and is now an advisory teacher, instead of being a class teacher in a special school, so she is still thinking about how to use it in her new role. Changes she has made include:

- Using techniques from MR in whole class lessons – especially 'mental maths starter' section of lessons
- Effects on the whole of her lessons in the special school, as these have scope for much practical work. She tells other teachers that MR is useful training for whole class teaching.
- Changing how maths was organised across the school: setting Key Stage 2 pupils, and running a Maths Recovery class.

In role as advisory teacher, often recommending individual programmes for pupils with severe learning difficulties. Sharing her resources with teachers whom she advises.

APPENDIX G(5)

ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 5** **Date:**

Constructs

1	Tries to make children enjoy lesson through success	↔	Just tries to get across information
2	Differentiates so all children can participate	↔	Teaches all children to same level – only differentiates by support
3	Good knowledge of maths	↔	Poor knowledge of maths
4	Understands how children learn maths	↔	
5	Keeps repeating things if child doesn't understand	↔	Goes back to earlier stage to find out what the problem is
6	Blames child and feels irritated by them if they are stuck	↔	Blames own teaching for not being at right level
7	Good behaviour management so children quiet & don't muck about	↔	Chaotic, noisy classroom: children off-task
8	Uses a variety of 'props' to help children understand tasks	↔	Expects children to work with just numbers, no concrete support
9	Teaches numeracy very well	↔	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range 0 to 32. High and low values highlighted for discussion.

CONSTRUCTS UNREVERSED (columns); ***CONSTRUCTS REVERSED*** (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		5	5	3	19	18	9	2	1
2	19		10	6	20	17	12	7	4
3	19	18		6	18	17	6	5	6
4	17	16	18		18	15	10	5	2
5	5	2	10	6		3	16	17	20
6	6	1	11	5	19		15	16	17
7	19	16	22	18	14	13		9	10
8	18	17	17	15	7	8	19		3
9	19	18	18	16	4	5	18	18	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		13	25	28	10	18	18	4
2	Me just before MR training			11	15	9	5	5	13
3	Me now				3	19	9	9	25
4	The best teacher I could be					20	10	10	26
5	A teacher I disliked						10	12	8
6	My best teacher							4	16
7	Professionally respected colleague								16
8	Colleague I disagree with								

APPENDIX G(5) (contd)

DISCUSSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 5 Date:

The interviewee quite readily verbalised her thoughts on the topic, which was important to her in her professional life, so she had previously reflected upon it. Sometimes complex or multiple constructs were generated, and 'laddering' was used to unpack these into distinct constructs.

In looking at the relationships between constructs, we see a cluster, positively associated with the donated overall construct, 'teaches numeracy very well'(9). This cluster includes 'tries to make children enjoy the lesson through success'(1); 'understands how children learn maths'(4); 'uses a variety of props to help children understand tasks'(8) and 'differentiates so all children can participate'(2). Construct 5 ('keeps repeating things if child doesn't understand') is negatively related to this cluster, via a strong negative relationship with construct 2 ('teaches children at same level – only differentiates by support'). Construct 6 ('blames child and feels irritated by them if they are stuck') is also negatively related to the cluster. In discussing which of the constructs were most important for good teaching, the interviewee felt that they were all necessary, although 1,6,2 and 4 were more central than 5,3,7 and 8.

For this interviewee, pupil enjoyment through success is central to good numeracy teaching. Pupil success will be achieved by the teacher using her knowledge of how children learn, to differentiate work so that all children can participate. Concrete apparatus will be used where appropriate. Good behaviour management plays a role, in creating an orderly room where pupils can work well. If a pupil is not successful, this will be because the teacher has not been working at the right level, and the teacher needs to go back to an earlier stage and analyse where the pupil's difficulty lies.

In examining the relationships between the grid elements, we see that 'me when new to teaching'(1) gets ratings similar to 'colleague I disagree with'(8). On the other hand, 'me now'(3) is rated similarly to 'the best teacher I could be'(4), and very dissimilarly to elements 1 and 8. The elements 2 ('me just before MR training'), 6 ('my best teacher') and 7 ('professionally respected colleague') receive similar ratings to each other, and are positively rated on the overall construct 9 ('teaches numeracy very well'). Thus:

This teacher feels that she has changed a lot in the 12 years since she began teaching, and is now not only teaching numeracy very well, but is very similar to 'the best teacher I could be'. Considerable change has happened in the two years since her MR training: she reports change on all constructs except number 7 (good behaviour management). The greatest change happened on construct 5: when children do not understand, she now goes back to an earlier stage to find out what the problem is, rather than repeating previous approaches.

She describes changes which she has made in her practice, since Maths Recovery training:

- She assessed all the Year2 pupils, at the start of the year, using the MR assessment materials.
- In class teaching of maths, she grouped the children according to their MR Stage, and used teaching activities from the programme to try to move them on to the next Stage.
- She reduced the time spent in whole class teaching.
- She placed greater emphasis on children explicitly exploring their methods of solving problems.
- She observed which stage children were at, and did not expect them to use strategies which were too sophisticated for their stage: she provided appropriate 'props', so that they could take part and solve the problems independently.

Her role in the school has changed, so that she has responsibility for Special Needs teaching, and does not have a class. She intends to do the following:

- Test all the Key Stage 1 pupils with the MR assessments, and group them for numeracy teaching according to their MR Stage, across year groups.
- Deliver individual MR programmes to some pupils with particular weaknesses.

Deliver support to some pupils through small group work, using MR approaches and materials.

APPENDIX G(6)
ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 6** **Date:**
Constructs

1	Teaches what he is told: follows schemes closely	◄──►	Teaches to fit what individual children can do
2	Well-informed about what individual children can do	◄──►	Lacks skill in analysing what children do
3	Believes maths is very important, & spends much time on it	◄──►	Doesn't enjoy doing or teaching maths: spends minimum time on it
4	Self-confident	◄──►	Lacks confidence: puts self down
5	Serious manner: humour not used	◄──►	Laid-back, jovial manner
6	Approachable – has time for children	◄──►	Frightening: uses verbal put-downs
7	Wants children to be confident with their maths	◄──►	Wants children just to listen & understand straight away
8	Understands progression in mathematical learning	◄──►	Focus on getting through curriculum, rather than understanding
9	Teaches numeracy very well	◄──►	Teaches numeracy very poorly

Similarities Between Constructs
Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED

CONSTRUCTS REVERSED	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		20	14	14	8	19	21	20	19
2	2		8	12	11	5	5	4	3
3	10	14		10	11	9	7	6	5
4	12	12	12		7	14	15	16	13
5	13	7	9	12		16	16	15	14
6	5	19	17	12	8		4	5	4
7	7	21	17	12	10	24		5	2
8	4	24	16	11	9	21	22		3
9	5	19	15	10	8	22	22	21	

Similarities Between Elements
Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		8	13	15	13	10	12	11
2	Me just before MR training			9	11	19	10	6	15
3	Me now				4	26	5	3	22
4	The best teacher I could be					28	5	5	24
5	A teacher I disliked						24	23	12
6	My best teacher							2	21
7	Professionally respected colleague								19
8	Colleague I disagree with								

APPENDIX G(6) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 6 Date:

The topic was of great interest to the interviewee, who engaged deeply with it, reflecting on how it had changed his self-perception. He found it quite difficult, during the interview, to verbalise his constructs. Triads were sometimes not helpful, and pairs were used instead, together with some 'pyramiding', to extend the variety of constructs. The elements were more easily generated, and all constructs were seen as relevant to all elements. The interviewee remarked that the elements he viewed positively were all primary teachers, and those he viewed negatively were secondary teachers.

In looking gat the relationships between his constructs, we see a tightly clustered group, which are related similarly to the donated construct, 'teaches numeracy very well'(6). This group includes: 'well informed about what individual children can do'(2); 'wants children to be confident with their maths'(7); 'understands progression in mathematical learning'(8); 'approachable, has time for children'(6). Construct 1, 'teaches what he is told: follows schemes closely' is negatively related to this group. When the interviewee was asked to say which of the constructs were most important for good teaching, he said that constructs 1,2,6,7 & 8 were more important than the others. (This is the tight cluster which is described above.)

For this interviewee, a good numeracy teacher is one who understands progression in children's mathematical learning, and has a desire for children to be confident and to develop their understanding, rather than just get through the work. Such a teacher has time for children, and an approachable manner, and is well-informed about what each child can do. He is teaching to fit what each child can do, rather ran just following set schemes.

Turning to the relationships between the grid elements, we see that the interviewee rates 'me now'(3) as close to 'my best teacher'(6), 'respected colleague'(7) and 'the best teacher I could be'(4). This group of elements are all quite similarly to each other, and very differently from elements 5 ('teacher I disliked') and 8 ('colleague I disagree with'). Thus:

The interviewee has a positive image of himself as a teacher, seeing himself as being like those elements he respects, and unlike those he regards negatively. Comparing 'me now'(3) with 'me just before MR training'(2), it is apparent that the interviewee feels he has improved (ie become more like 'the best teacher I could be') since MR training, on all constructs except 5 ('approachable, has time for children'). Discussion showed that this teacher has recently been through some very negative professional experiences, and feels that the Mathematics Recovery training has played a strong role in restoring his confidence in himself as an effective teacher, as well as giving him some new skills.

He describes the changes which he has made in his practice, since the training, and those he intends to make:

APPENDIX G(6) (contd)

- Before training, he was working with small withdrawal groups, with able children and with those experiencing difficulties. Since training, he is also doing individual programmes for pupils with difficulties.
- He is using spatial awareness tasks more, and giving pupils more visual cues. This includes teaching finger and dot patterns, and using tens strips and other visual stimuli as prompts. This includes his work with able pupils, where previously he tended to use numerals and symbols exclusively.
- He now used the MR assessment schedules to assess all the Year 1 pupils, and uses this information to select pupils for small group work, and for individual programmes.
- Mathematics Recovery activities from the teaching programme are used in the small group work.
- He intends to continue with both the group and the individual work. He feels that some children do need the individual programme, and that this is very effective, as well as cost-effective: "every single child I've done individual programmes with has been either a bit more confident, or hugely more confident."

APPENDIX G(7)
ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 7** **Date:**
Constructs

1	Constantly improves teaching skills through experiences	↔	Has not improved teaching through experience – stuck in a rut
2	Perceives only one way of teaching something	↔	Keeps trying different methods to find one that works
3	Teaches topics as an entity –doesn't think of breaking things down	↔	Breaks work down to make it easy for children to learn
4	Encourages child talk & activity in class	↔	Heads down, silent worksheets
5	Knows what she wants children to learn, designs structures to lead there	↔	Direct teaching of skills
6	Has empathy for pupils' problems & feelings	↔	Attributes pupil difficulties to lack of ability
7	Able quietly to set & maintain behavioural standards in class	↔	Finds it difficult to maintain discipline
8	Enthusiastic about the subject	↔	Just teaching it because they have to
9	Teaches numeracy very well	↔	Teaches numeracy very poorly

Similarities Between Constructs
Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED

ONE CONSTRUCT REVERSED

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		20	20	13	14	3	9	5	7
2	2		0	11	14	21	17	19	15
3	2	18		11	14	21	17	19	15
4	11	11	11		11	14	8	12	10
5	14	14	14	3		13	13	13	9
6	23	3	3	10	17		10	6	6
7	17	9	9	10	9	18		8	8
8	21	5	5	10	11	22	18		4
9	17	5	5	6	13	18	14	16	

Similarities Between Elements
Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		8	12	12	14	11	7	9
2	Me just before MR training			4	8	21	7	3	14
3	Me now				4	24	5	5	18
4	The best teacher I could be					24	5	7	22
5	A teacher I disliked						19	19	10
6	My best teacher							8	16
7	Professionally respected colleague								15
8	Colleague I disagree with								

APPENDIX G(7) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 7 Date:

The interviewee thought deeply during the session, taking some time and effort to articulate her constructs. She found some aspects difficult: it was hard for her to nominate the negative elements (5 & 8), and for her to generate ratings for the elements which were aspects of herself (elements 1,2 & 3). Triads were found quite helpful in the elicitation process, and use was made of laddering upwards and laddering downwards, when it was hard to generate new constructs.

In looking at the relationships between constructs, we see a tight cluster of constructs which are associated with the overall construct 'teaches numeracy very well' (9). This cluster includes construct 6, 'has empathy for pupils' problems & feelings'; construct 8, 'enthusiastic about the subject'; construct 1, 'constantly improves teaching skills'; construct 2 reversed, 'keeps trying different methods to find one that works'; construct 3 reversed, 'breaks work down to make it easy for children to learn'. When asked to say which of the constructs were most important for her idea of good teaching, she said that 1, 2 reversed and 3 reversed were most important, but that all of them make an important contribution.

> ***For this interviewee, good numeracy teachers are those who constantly improve their teaching skills through experience. To achieve this, they try out different methods to find ones which work, and they base their methods on breaking the work down into tasks which are easy enough for the children to do. These teachers are enthusiastic about teaching maths, and they see the pupils as able to succeed. They have empathy for pupils' feelings and difficulties. they are also able to maintain discipline in the classroom.***

Looking at relationships between the grid elements, we see that the elements 'me now'(3), 'the best teacher I could be'(4), 'my best teacher'(6) and 'professionally respected colleague'(7) are rated similarly on the constructs as a whole. 'The best teacher I could be'(4) is rated similarly to 'my best teacher'(6). On the other hand, 'the best teacher I could be'(4) is seen as very dissimilar to 'a a teacher I disliked'(5) and 'colleague I disagree with'(8). Thus:

> ***This teacher has a positive view of herself as a teacher of numeracy, believing that, after 27 years experience, she is quite close to being as good as she can be. She believes she could still improve her classroom discipline (perhaps because she is out of practice at handling whole classes, as she currently works mainly with individual pupils), and that she could be even more enthusiastic about numeracy than she currently is. Despite her long experience, she feels she has shown improvements since her Maths Recovery training, and that these improvements are in the three most important aspects of the teaching: learning through experience(1), evolving new methods(2) and breaking tasks down for children(3). She says that, although she has always had empathy for children's' difficulties, she now knows more about what to do in order to help them.***

APPENDIX G(7) (contd)

She describes some changes which she has made to her practice, as a result of the Maths Recovery training:

- Improved content of individual programmes: these are now more structured, and are planned so as to comprise targets and activities which will build up skills from a known baseline.
- A fundamental change of approach, with an emphasis on leading children towards understanding. She now tries to find a way to lead children to discover methods of solving problems, rather than teaching them mathematical methods, which they may not understand.
- She works in two different school, and she does individual Maths Recovery programmes in each school. All pupils with Statements of Special Educational need for learning difficulties are given MR programmes.
- She has adapted the MR programmes, to include more written responses: this was done in order to help the programmes to generalise into the mainstream classroom.

APPENDIX G(8)

ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 8** **Date:**

Constructs

1	Aims to understand child's thinking	◄——►	Believes child is not capable of understanding
2	Tries to match teaching method to where the child is	◄——►	Presents generic lessons, based on own expectations
3	Knows about course of children's mathematical development	◄——►	No understanding of children's development
4	Aim for children to enjoy succeeding	◄——►	Not bothered about how children feel
5	Has high expectations for children	◄——►	Has low expectations of children's ability
6	Uses questions to prompt children to analyse their own thinking	◄——►	Just marks things right or wrong
7	Makes ignorant assumptions of what children can do	◄——►	Assesses knowledgably & in detail what children can do
8	Empowers children to work confidently & independently	◄——►	Directs children all the time
9	Teaches numeracy very well	◄——►	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns); *ONE CONSTRUCT REVERSED* (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		5	5	5	5	2	23	0	2
2	25		10	8	8	3	26	5	7
3	19	20		10	10	7	18	5	5
4	23	24	20		0	7	22	5	5
5	5	24	20	28		7	19	5	5
6	24	27	19	23	23		25	2	4
7	23	6	6	10	10	5		23	23
8	22	5	19	23	23	24	5		2
9	22	23	19	23	23	22	5	22	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		17	20	21	11	9	19	15
2	Me just before MR training			3	4	20	12	2	32
3	Me now				1	21	15	1	35
4	The best teacher I could be					22	16	2	36
5	A teacher I disliked						8	20	14
6	My best teacher							14	20
7	Professionally respected colleague								34
8	Colleague I disagree with								

APPENDIX G(8) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 8 Date:

This interviewee found aspects of the process difficult, and often took time to think. She found it hard to nominate element 5 ('a teacher I disliked'), and to use this element in triadic elicitation. As the interview progressed, she found herself stuck in some 'constellatory' thinking, where all the constructs she generated were aspects of the same overarching one, related to her view of 'good teaching', and she was unable to think of other, independent dimensions to her view of teaching. To break out of this, we used the 'character sketch' method, with the interviewee describing what a pupil might say about her as a teacher. This was a helpful approach, and caused her to generate a new idea ('helps me with work'), which then led to three new constructs, by using the pyramiding technique.

In looking at the relationships between constructs, we see a cluster which is associated with the overall construct 'teaches numeracy very well'(9). This cluster includes construct 1, 'aims to understand children's thinking'; construct 6, 'uses questions to prompt children to analyse their own thinking' and construct 8, 'empowers children to work confidently and independently'. Construct 2, 'tries to match teaching method to where the child is' also forms a cluster with construct 6, 'uses questions to prompt children to analyse their own thinking' and construct 7 reversed, 'assesses knowledgably and in detail what children can do'. Constructs 4, 'aim for children to enjoy succeeding' and construct 5, 'has high expectations for children' are very closely related to each other, and quite closely related to the overall construct 9, 'teaches numeracy very well'. This pattern of relationships was hard to interpret, and further discussion with the interviewee was needed, before agreeing on the paragraph below:

> ***For this interviewee, good teachers are driven by aims and intentions: they want children to enjoy succeeding, they aim to understand individual children's thinking and they have high expectations for children. It is the understanding of the children's thinking which enables these teachers to develop knowledge about mathematical development, and this in turn enables them to develop their methods of teaching. The methods which characterise good maths teaching include detailed assessments of what each child can do, use of questions to prompt children to analyse their own thinking, matching teaching to where the child is, and empowering them to be confident and independent.***

Looking at the relationships between the grid elements, we see that the elements 'me just before MR training' (2), 'me now' (3), 'the best teacher I could be'(4) and 'professionally respected colleague'(7) are rated similarly on the constructs as a whole. Element 8, 'colleague I disagree with', is rated very differently from this group of elements. The element 'me now' (3) receives ratings which are almost identical to those of 'the best teacher I could be' (4) and to those of 'professionally respected colleague' (7).

APPENDIX G(8) (CONTD.)

This teacher has a very positive view of herself as a teacher of numeracy, and also believes that she has made recent improvements. She says she is better than she was just before the MR training, as she has more knowledge of mathematical development, and is more knowledgeable about detailed assessment. She says that she thinks she could improve still further, by extending her knowledge of children's mathematical development through getting more experience in using MR teaching. She says, "I always felt I had a 'blank wall' when it came to understanding what children were doing – that's what MR gave me. It took me to the place that I knew was there."

She describes some changes which she has made or intends to make to her practice, as a result of MR training:

- She thinks more about the different learning styles which children have, and tries to present tasks and materials in ways which will match these – e.g. by using colour in materials, to help children to make connections.
- She tries to put the different aspects of MR principles and methods into her teaching, whilst recognising that these are not separate 'tips for teachers', but are aspects of a coherent approach.
- She watches children more closely, to find out where they are in their learning process: this includes studying their body language, as well as what they say and do. She no longer makes assumptions, but observes instead.
- She intends to use the MR assessment materials in the school's individual assessment process for Special Needs support.
- She intends to explore grouping children for small group work on specific MR activities, e.g. running a short-term group for pupils needing to develop their knowledge of the Backward Number Sequence from 10 to 1.

APPENDIX G(9)

ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 9** **Date:**

Constructs

1	Experienced & knowledgeable	↔	Lacks experience, so less competent
2	Understands how children learn	↔	Relies on age-related expectations – no idea of structure of children's learning
3	Assesses where children are and matches teaching	↔	Unstructured assessment, not related to subsequent teaching
4	Good knowledge of number	↔	Has difficulty working with number – poor subject knowledge
5	Enjoys working with children	↔	Not enthusiastic or tolerant – shouldn't be there!
6	Want to help children move forward and do their best	↔	Wants their pay, and not interested in job satisfaction or helping children
7	Keen to improve as a teacher	↔	Lacks motivation, not interested in the job
8	Teaches more able pupils successfully, but struggles to teach less able	↔	Responds to learning needs of pupils at all levels
9	Teaches numeracy very well	↔	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns) / ***CONSTRUCTS REVERSED*** (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		3	3	6	11	9	7	18	2
2	19		0	5	10	8	6	21	1
3	19	20		5	10	8	6	21	1
4	16	15	15		7	7	5	18	4
5	21	22	22	23		2	4	25	9
6	21	22	22	21	28		2	25	7
7	19	20	20	16	26	26		23	5
8	6	5	5	6	5	6	3		20
9	18	19	19	16	23	23	21	4	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		2	11	14	18	8	12	7
2	Me just before MR training			11	12	18	6	12	5
3	Me now				1	27	5	1	14
4	The best teacher I could be					28	6	0	15
5	A teacher I disliked						22	28	13
6	My best teacher							6	9
7	Professionally respected colleague								15
8	Colleague I disagree with								

APPENDIX G(9) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 9 Date:

The interviewee engaged well with the topic, which she said was of importance for her, although she sometimes found it quite difficult to articulate her constructs. When generating the elements, she found it hard to nominate a 'teacher I disliked'. When generating constructs, she found the triadic method quite useful. However, she did not generate constructs which were common to teachers she regarded positively and those she regarded negatively: e.g. she got stuck when asked how elements 5 and 7 were alike. Generally, the constructs were used in a rather constellatory way, with a cluster of constructs which were associated with good teaching always going together. She frequently returned to ideas of 'structure' being important (constructs 2 & 3), as well as the affective aspects of motivation (constructs 6 & 7) and enjoyment (construct 5).

Looking at how the constructs relate to each other, one sees a tight cluster of constructs which are associated with the overall construct 9, 'teaches numeracy very well': this cluster includes 'understands how children learn' (2), 'assesses where children are and matches teaching'(3), 'experienced and knowledgeable'(1) and 'good knowledge of number' (4). There is a second cluster of constructs, relating to affect and motivation, which includes 'enjoys working with children' (5), 'wants to help children move forward and do their best' (6) and 'keen to improve as a teacher' (7). The construct 'responds to learning needs of pupils at all levels' (8 reversed) is also close to this cluster. This cluster is strongly negatively associated with 'teaches numeracy very poorly' (overall construct 9 reversed).

For this teacher, there are two main aspects of good numeracy teaching. The first relates to knowledge and understanding, both of the number system (construct 4) and of how children learn (construct 2), and to the application of this knowledge in the design of assessment and teaching (construct 3). A good teacher is well informed, and uses this knowledge in planning. The second aspect relates to motivation and enjoyment: a good teacher wants to help children improve (construct 6), enjoys working with them (5) and is keen to improve as a teacher (7). Teachers who are good at both of these aspects are seen as being able to respond to the learning needs of all pupils, rather than just to those of the more able.

Looking at the relationships between elements in the grid, we see a tight cluster of three elements which are rated very similarly, and which all receive highly positive ratings on the overall construct 'teaches numeracy very well' (9). These elements are 'professionally respected colleague' (7), 'me now' (3) and 'the best teacher I could be' (4). There is also a cluster formed of element 1, 'me when new to teaching' with element 2, 'me just before MR training', with element 8, 'colleague I disagree with' being more loosely connected to this cluster. This second cluster receives ratings on the overall construct which are in the middle of the scale.

This teacher feels that her numeracy teaching changed little in the 29 years since her initial training, but has improved considerably in the two terms

APPENDIX G(9) (contd)

since she started the MR training. She feels she is now very close to being as good a teacher of numeracy as she could be, although she also says she is still keen to improve (construct 7)! She rates 'me now' identically to the ratings she gives to 'professionally respected colleague', on the constructs which she generated: possibly, this colleague is serving as a model for excellent teaching.

She describes actual and intended changes in her practice:

- She is more focussed and specific, designing activities for particular purposes.
- She adapts the activities from the MR programme, to use with groups and classes – especially in the opening, 'mental and oral starter' parts of the lesson.
- She has a wider range of teaching ideas, and increased confidence.
- She hopes to do some MR programmes with individual children, though the opportunity for this has not yet arisen.
- She is keen to support colleagues who are involved in teaching number.

APPENDIX G(10)
ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 10** **Date:**
Constructs

1	Creative, fun way of teaching	↔	Lots of pressure to cover mounds of work
2	Wants children to work for themselves and reflect on what they do	↔	Wants them to sit & listen – be taught
3	Reluctant to speak out – inflexibly follows plans	↔	Confident, contributes to plans
4	Has wide range of teaching ideas	↔	Boring, uses same methods all the time
5	Understands mathematical vocabulary	↔	Doesn't understand mathematical vocabulary
6	Eager to learn about teaching	↔	Closed to new ideas
7	Very strict: doesn't let pupils choose	↔	Gives pupils free choice
8	Builds next step on child's existing understanding	↔	Pushes children when not ready
9	Teaches numeracy very well	↔	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns) / ***CONSTRUCTS REVERSED*** (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		7	15	10	14	7	14	3	7
2	19		16	9	11	10	15	8	8
3	15	14		15	25	22	9	16	20
4	14	17	15		10	9	14	7	7
5	16	19	7	20		11	24	11	7
6	17	18	8	13	19		17	6	6
7	8	11	21	10	6	7		13	19
8	17	18	14	15	17	14	7		6
9	15	18	10	13	23	16	3	14	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		4	17	24	11	14	21	16
2	Me just before MR training			17	24	13	12	21	16
3	Me now				7	20	11	8	13
4	The best teacher I could be					27	16	7	16
5	A teacher I disliked						13	22	13
6	My best teacher							15	6
7	Professionally respected colleague								17
8	Colleague I disagree with								

APPENDIX G(10) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 10 Date:

The interviewee was interested in the topic, often becoming quite animated, and spontaneously commenting on positive changes in her teaching and thinking, since the MR training. She found it quite easy to nominate the elements, and to rate them on her constructs, and she used the full range of the rating scale. In generating constructs, triads were not found helpful, so pairs were used. She often used a series of short phrases to generate a complex cluster of constructs, which needed 'unpacking' into several distinct constructs, through discussion.

Looking at the relationships between constructs, we see a cluster which is closely related to the overall construct, 'teaches numeracy very well' (9). This cluster includes 'builds next step on child's existing understanding' (8); 'eager to learn about teaching' (6); 'creative, fun way of teaching' (1); 'gives pupils free choice' (7 reversed) and 'confident, contributes to plans' (3 reversed). The strongest relationships in the grid are between constructs 1 and 8 – suggesting that a 'creative, fun way of teaching' is associated with 'builds next step on child's existing understanding' – and between constructs 9 and 7 reversed – suggesting that good numeracy teaching is associated with letting pupils choose what to do. When she was asked to say which constructs were core ones for her, this interviewee said this was hard, as they were all important.

For this interviewee, a good numeracy teacher is open to new ideas about teaching, and uses a wide range of teaching methods. There is an aim for children to be motivated to develop their own understanding, and this leads the teacher to let children choose what to do, and to be sensitive to the child's existing level of understanding, offering activities which match this rather than focussing on covering lots of curriculum material. A good teacher understands mathematical ideas well, and is therefore confident both to plan activities for children, and to adapt these a necessary, in response to what pupils do.

Looking at the relationships between grid elements, we see that 'me when new to teaching' (1) and 'me just before MR training' (2) receive similar, not very positive ratings. There is a cluster of three elements which are viewed as similar to each other, and which all receive high ratings on the overall construct 'teaches numeracy very well' (9). This cluster consists of 'me now' (3); 'the best teacher I could be' (4) and 'professionally respected colleague' (7). Elements 6 (my best teacher) and 8 (colleague I disagree with) are seen as similar to each other.

This interviewee, who is a teaching assistant, sees herself as now close to the best she could be, and feels that she has improved as much in the two terms since starting the training, as she did in the previous ten years of work as a teaching assistant. She now sees herself as similar to 'professionally respected colleague', and she speaks of having become confident to share planning effectively with a teacher, knowing that they have a common view of how to support the children's learning.

APPENDIX G(10) (contd)

She describes changes which she has made, or intends to make, in her practice:

- She is more aware of gaps in children's understanding, especially when she observes them during 'oral mental starters'. This applies especially to backward counting, and she has been using activities from MR to work on this.
- She is integrating teaching approaches and activities from MR into the classroom as much as possible, alongside the published scheme which the school currently uses.
- She is hoping to assess all pupils in a year group, twice during the year, and to use the results to form and teach small groups for aspects of number work.

She may in future deliver some MR programmes to individual children, although at the moment she has no pupils whose needs would justify (financially) giving this high level of support

APPENDIX G(11)

ANALYSIS OF INDIVIDUAL GRID **Interviewee No: 11** **Date:**

Constructs

1	Well organised	⟷	Not thoroughly planned
2	Knows how children learn	⟷	Doesn't know how children learn
3	Good grasp of number	⟷	Not confident with number
4	Talks over the children, gives no chance to respond	⟷	Receptive, relaxed, calm
5	Flexible, changes plans according to pupils' needs	⟷	Rigidly follows plans: loses sight of pupils' needs
6	Has just one way to teach each thing	⟷	Understands a range of ways to teach things
7	Brisk-paced lessons	⟷	Vague, sloppy, purposeless
8	Makes lessons fun and interesting	⟷	Lessons are stressful and difficult
9	Teaches numeracy very well	⟷	Teaches numeracy very poorly

Similarities Between Constructs

Figures are 'simple differences', range from 0 to 32. High and low values are highlighted for discussion.

CONSTRUCTS UNREVERSED (columns); *CONSTRUCTS REVERSED* (rows)

	1	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*
1		7	6	15	12	15	2	7	6
2	15		7	14	11	16	9	6	1
3	14	12		9	12	13	6	7	6
4	9	11	13		17	10	13	14	15
5	12	3	10	7		15	12	5	10
6	7	3	5	14	11		15	12	15
7	16	14	12	11	10	9		7	8
8	11	13	9	8	15	8	11		5
9	14	16	12	9	16	5	12	13	

Similarities Between Elements

Figures are 'simple differences', range from 0 to 36. High and low values are highlighted for discussion.

		1	*2*	*3*	*4*	*5*	*6*	*7*	*8*
1	Me when new to teaching		4	10	22	13	11	17	15
2	Me just before MR training			10	22	11	11	15	11
3	Me now				12	11	7	7	13
4	The best teacher I could be					18	11	7	19
5	A teacher I disliked						10	12	6
6	My best teacher							12	14
7	Professionally respected colleague								12
8	Colleague I disagree with								

APPENDIX G(11) (contd)

DISCUSSION OF ANALYSIS OF SIMILARITIES
Interviewee No: 11 Date:

The interviewee found the topic interesting, and spontaneously talked about how the training had changed her practice and thinking. She quite readily identified teachers to use as grid elements. In generating constructs, she found the use of triads quite helpful, tending to generate several, quite global constructs from one triad. 'Laddering down' and discussion were used, to separate and refine these constructs. All constructs were seen as relevant to all the elements, and the interviewee found it fairty easy to rate the elements, and used the full 1-5 range of ratings.

Looking at the relationships between the construct, we see a cluster which are closely related to the overall construct 'teaches numeracy very well' (9), and to each other. This includes 'well organised' (1), 'brisk-paced lessons' (7), 'knows how children learn' (2), 'makes the lesson fun and interesting' (8) and 'flexible, changes plans according to pupils' needs' (5). Construct 3 (good grasp of number) is also linked to this cluster. Constructs 4 ('talks over the children: gives no chance to respond') and 6 ('has just one way to teach each thing') are negatively related to the cluster, and to the overall construct 'teaches numeracy very well' (9). The interviewee rated constructs 1 ('well organised'), 2 ('knows how children learn') and 3 ('good grasp of number') as the most important for good numeracy teaching, but said that the others, which were also necessary, would follow on from those three.

For this interviewee, underlying knowledge and understanding (both of learning and of teaching) is the key to good numeracy teaching. Thorough planning and good organisation are also important. If these aspects are in place, other facets of good numeracy teaching are likely to develop. A good numeracy teacher listens to the child in a relaxed way. Lessons are fun and interesting, and this is achieved through being flexible around plans in response to pupils' needs, as well as having a wide range of teaching methods available from which to choose.

Turning to the relationships between grid elements, we see that the interviewee rates herself just before MR training (element 2) similarly to herself when new to teaching (element 1). These two elements are not very similar to 'me now' (3), who is closer to 'my best teacher' (6) and to 'professionally respected colleague' (7). 'Colleague I disagree with' (8) and 'a teacher I disliked' (5) are rated quite similarly to each other, and are dissimilar to all three 'self' elements (1, 2 &3). Examining how the 'self' elements are rated on the overall construct 'teaches numeracy very well' (9) shows that 'me when new to teaching' (1) and 'me just before MR training' (2) both receive a poor rating of 4, whilst 'me now' (3) has improved considerably, getting a good rating of 2.

This interviewee feels that her numeracy teaching did not improve significantly between starting as a teacher and just before MR training. However, it has improved considerably, since starting the MR training. She has made most change in her knowledge of how children learn (construct 2)

and her understanding of a range of ways to teach things (construct 6). She

made no change on construct 4, as she has always been 'receptive, relaxed and calm', believing it is important to give children opportunities to respond. The interviewee believes that, although she has improved a lot, she can still get better. Further improvement could still happen on constructs 5, 7 and 8: this would involve the flexible use of planning and organisation to support differentiation, so that each pupil experiences a purposeful, engaging lesson, which they find fun. Discussion showed that confidence has been an issue for this interviewee, who says that she herself struggled with numeracy, when she was a pupil. She comments that she was surprised and pleased at the really good progress made by the pupil whom she taught during her MR training: "I hadn't thought that (pupil name) could come on that much." As the interviewee only finished the MR training a few weeks before the interview, she may still be in a relatively early stage of consolidating the application of the MR training in her work.

She describes some changes which she has already made in her practice, and some which she intends to make:

- She now discusses numerical methods more with pupils in class – both getting them to talk about how they might do a task, and getting them to 'tell me how you did that', leading her to guide them to develop new methods.
- She makes more focussed observations of what pupils do in class. This leads to her noticing gaps in their understanding, even with quite able pupils, and to her selecting activities to develop these areas.
- Having seen the excellent progress made by the pupil with whom she worked on an individual programme, she intends to do more of these.

She may use the MR assessment tools with whole groups, and use the results to plan work for the pupil.

APPENDIX H

Table 4.4: INITIAL RELIABILITY TABLE

Before Rearrangement:

Collaborator→ ***Interviewer ↓***	Knowledge of maths	Confident, organised manner	Teaching style & personal; Classroom manner	Differentiating in respect of children as individual learners	Allowing children to function with degrees of independence	Confidence to be flexible	Professional conduct of lesson	Classroom management	Ability to empathise with children	Motivates children to learn	Understanding how children learn number	Understanding how children learn	Feels working with children is important	Happy classroom performer	Reflective, inspirational practice	Wants children to achieve independence	Maths is most important subject in school	Miscellaneous
Empowering children towards independent learning		7.5	4.7		2.8,7.4 8.6,8.8 10.7		3.8,			1.8				11.4		10.2		
Following plans inflexibly		11.5	7.2			3.3,4.4								1.1,				
Assessing what individual children can do				9.3								8.7	6.2					
Differentiating to match tasks & teaching methods to child			8.2	2.7,4.2 5.2,10.8		6.1					6.8						9.8	
Knowing about number	1.6, 4.5 5.3, 9.4 10.5, 11.3																	

Collaborator→ ***Interviewer ↓***	Knowledge of maths	Confident, organised manner	Teaching style & personal; Classroom manner	Differentiating in respect of children as individual learners	Allowing children to function with degrees of independence	Confidence to be flexible	Professional conduct of lesson	Classroom management	Ability to empathise with children	Motivates children to learn	Understanding how children learn number	Understanding how children learn	Feels working with children is important	Happy classroom performer	Reflective, inspirational practice	Wants children to achieve independence	Maths is most important subject in school	Miscellaneous
Knowing how children learn											2.3,5.4 8.3	9.2,11.2						
Having a range of teaching ideas and methods			11.6													5.8	10.4	
Managing behaviour in class								2.4,5.7 7.7										
Deriving teaching strategies from understanding of no.	4.6		5.5									7.3						
Teacher motivation & commitment													1.3,9.5 9.6	2.1,3.6	2.2		4.8,6.3 7.8	
Helping children to enjoy success in maths by positive methods			3.7				6.5,10.1			1.5,3.2 5.1,6.6 8.4				11.8	1.4	2.6,6.7		

Collaborator→ ***Interviewer ↓***	Knowledge of maths	Confident, organised manner	Teaching style & personal; Classroom manner	Differentiating in respect of children as individual learners	Allowing children to function with degrees of independence	Confidence to be flexible	Professional conduct of lesson	Classroom management	Ability to empathise with children	Motivates children to learn	Understanding how children learn number	Understanding how children learn	Feels working with children is important	Happy classroom performer	Reflective, inspirational practice	Wants children to achieve independence	Maths is most important subject in school	Miscellaneous
Respect for children – empathy & high expectations									3.1,7.6 8.5			8.1	4.1		5.6			
Teacher development														7.1	3.5,9.7 10.6			
Structuring & organising lessons		2.5,4.3 11.1					11.7											
Teacher wisdom						3.4,9.1	1.7											
Teacher confidence						1.2,6.4 10.3												
Miscellaneous																		

Table 4.4 (contd): INITIAL RELIABILITY TABLE

After rearrangement:

Collaborator→ ***Interviewer↓***	Knowledge of maths	Motivates children to learn	Allowing children to function with degrees of independence	Differentiating in respect of children as individual learners	Feels working with children is important	Understanding how children learn number	Ability to empathise with children	Confident, organised manner	Reflective, inspirational practice	Classroom management	Confidence to be flexible	Happy classroom performer	Professional conduct of lesson	Wants children to achieve independence	Understanding how children learn	Teaching style & personal; Classroom manner	Maths is most important subject in school	Miscellaneous
Knowing about number	1.6, 4.5 5.3, 9.4 10.5, 11.3																	
Helping children to enjoy success in maths by positive methods		1.5,3.2 5.1,6.6 8.4							1.4			11.8	6.5,10.1	2.6,6.7		3.7		
Empowering children towards independent learning		1.8	2.8,7.4 8.6,8.8 10.7					7.5				11.4	3.8,	10.2		4.7		
Differentiating to match tasks & teaching methods to child				2.7,4.2 5.2,10.8		6.8					6.1					8.2	9.8	
Teacher motivation & commitment					1.3,9.5 9.6				2.2			2.1,3.6					4.8,6.3 7.8	

Collaborator→ / *Interviewer ↓*	Knowledge of maths	Motivates children to learn	Allowing children to function with degrees of independence	Differentiating in respect of children as individual learners	Feels working with children is important	Understanding how children learn number	Ability to empathise with children	Confident, organised manner	Reflective, inspirational practice	Classroom management	Confidence to be flexible	Happy classroom performer	Professional conduct of lesson	Wants children to achieve independence	Understanding how children learn	Teaching style & personal; Classroom manner	Maths is most important subject in school	Miscellaneous
Following plans inflexibly								11.5			3.3,4.4	1.1,				7.2		
Teacher wisdom											3.4,9.1		.1.7					
Having a range of teaching ideas and methods														5.8		11.6	10.4	
Assessing what individual children can do				9.3	6.2										8.7			
Deriving teaching strategies from understanding of no.	4.6														7.3	5.5		
Miscellaneous																		

Reliability Calculation

Index A = (No of constructs lying on the diagonal, in agreed categories) / Total no. of constructs
= 41/88
= 46.6%

Index B = (No of constructs lying on the diagonal, in agreed categories / No of constructs in agreed categories
= 41/49
= 83.7%

Lightly shaded area shows agreed categories, and darker shading on diagonals shows constructs which were placed in the same categories by the interviewer and by the collaborator.

APPENDIX I

Table 4.5: FINAL RELIABILITY TABLE, after revision of category system

Collaborator→ *Interviewer↓*	Knowledge of maths	Motivates children to learn	Wants & facilitates children to function with independence	Differentiating in respect of children as individual learners	Feels working with children is important	Enthusiastic commitment to teaching	Understanding how children learn	Understanding how children learn number	Ability to empathise with children	Confident, organised delivery of profess planned lesson	Reflective, inspirational practice	Classroom management	Confidence to be flexible	Teaching style & personal classroom manner
Knowing about number	1.6, 4.5 5.3, 9.4 10.5, 11.3													
Helping children to enjoy success in maths by positive methods		1.5, 3.2 5.1, 6.6 8.4, 10.1	2.6			11.8								
Empowering children towards independent learning		1.8	2.8, 3.8 6.7, 7.4 7.5, 8.6, 8.8, 10.2, 10.7											4.7
Differentiating to match tasks & teaching methods to child				2.7, 4.2, 5.2, 6.1, 6.2, 8.2, 8.7, 9.3, 9.8, 10.8,										
Values working with children					1.3, 9.5, 9.6									

Collaborator→ ***Interviewer ↓***	Knowledge of maths	Motivates children to learn	Wants & facilitates children to function with independence	Differentiating in respect of children as individual learners	Feels working with children is important	Enthusiastic commitment to teaching	Understanding how children learn	Understanding how children learn number	Ability to empathise with children	Confident , organised delivery of profess planned lesson	Reflective, inspirational practice	Classroom management	Confidence to be flexible	Teaching style & personal classroom manner
Enthusiastic commitment to teaching						2.1, 2.2, 3.6, 4.8, 6.5, 7.8								
Understanding how children learn							9.2, 11.2							
Knowing how children learn number								2.3, 5.4 6.8, 8.3						
Respect for children: empathy & high expectations									3.1, 4.4 7.6, 8.1, 8.5					
Structuring & delivering organised lessons										2.5, 4.3 4.6, 5.5 7.3, 11.1 11.5 11.7				
Teacher development											1.1, 1.4 3.5, 5.6 7.1. 9.7 10.6			

Collaborator→ / Interviewer ↓	Knowledge of maths	Motivates children to learn	Wants & facilitates children to function with independence	Differentiating in respect of children as individual learners	Feels working with children is important	Enthusiastic commitment to teaching	Understanding how children learn	Understanding how children learn number	Ability to empathise with children	Confident , organised delivery of profess planned lesson	Reflective, inspirational practice	Classroom management	Confidence to be flexible	Teaching style & personal classroom manner
Managing behaviour in class												2.4, 5.7 7.7		
Teacher confidence in their philosophy & ability to realise it													1.2, 1.7 3.3, 3.4 4.4, 6.4 9.1, 10.3	
Personality & style of delivery														3.7, 6.5 11.4
Having a range of teaching ideas & methods														5.8, 7.2 10.4 11.6

Note: there are no uncategorized constructs, so there is no 'miscellaneous' column.

Reliability Calculation

Index A = (No of constructs lying on the diagonal, in agreed categories) / Total No of constructs
= 80/88
= 90.1%

Index B = (No of constructs lying on the diagonal, in agreed categories) / No of constructs in agreed categories
= 80/84
=95.2%

APPENDIX J

LIST OF CONSTRUCTS GENERATED BY ALL ELEVEN INTERVIEWEES

Interviewee 1

1.1	Works out of safe zone: challenges philosophy & beliefs	Always works the same way, sticks with what they know best
1.2	Confident	Insecure
1.3	Tries to give children their absolute best	Bone idle – just in the job for the pension!
1.4	Does inspirational teaching	Doesn't understand what is good practice
1.5	Enthuses children to develop their own learning	Motivates children through negative/punitive means
1.6	Very good subject knowledge	Very poor subject knowledge
1.7	Has secure belief in their philosophy of teaching	Has confused beliefs/philosophy of teaching
1.8	Facilitates and inspires confidence in others	Dictator – tells others what to do

Interviewee 2

2.1	Committed to the job	Marking time, underperforming
2.2	Enjoys the job	Totally disillusioned
2.3	Knows how children learn number	No knowledge of how they learn number
2.4	Good behaviour management	Poor behaviour management
2.5	Structures their teaching	Haphazard approach to teaching
2.6	Wants children to enjoy maths	Indifference to children's enjoyment
2.7	Provides work to stretch each child	No differentiation in work provided
2.8	Promotes independent learning	Spoon-feeds children

Interviewee 3

3.1	Empathises with child	Dictates to child – tells them what to do
3.2	Motivates by fear – gets cross	Makes work fun so child wants to learn
3.3	Willing to change	Inflexible – clings to old methods
3.4	Naive about teaching	Knowledgeable & skilled in the classroom
3.5	Plans & reflects on teaching	Disenchanted – doesn't reflect on teaching
3.6	Dedicated to the job	Not bothered about the job – a slacker
3.7	Patient: is positive and calm, doesn't rush children	Impatient: flustered, cross
3.8	Present task & gives children space to attempt it	Presents task & tells children how to solve it

Interviewee 4

4.1	Values people for what they are: not prejudiced	Prejudiced: no attempt to empathise with others
4.2	Starts from where children are	Starts from where they think children

			should be
4.3	Structures lessons well, & makes this clear to pupils	↔	Looks disorganised, to an observer
4.4	Rigid, inflexible: set ways of doing things	↔	Relaxed approach, flexible
4.5	In-depth knowledge of number	↔	No knowledge of number
4.6	Great understanding of teaching number	↔	No understanding of teaching number
4.7	Interacts to draw things from pupils	↔	'chalk & talk'
4.8	Wants children to enjoy the subject & want to learn more	↔	Just comes to work for the monthly payslip

Interviewee 5

5.1	Tries to make children enjoy lesson through success	↔	Just tries to get across information
5.2	Differentiates so all children can participate	↔	Teaches all children to same level – only differentiates by support
5.3	Good knowledge of maths	↔	Poor knowledge of maths
5.4	Understands how children learn maths	↔	
5.5	Keeps repeating things if child doesn't understand	↔	Goes back to earlier stage to find out what the problem is
5.6	Blames child and feels irritated by them if they are stuck	↔	Blames own teaching for not being at right level
5.7	Good behaviour management so children quiet & don't muck about	↔	Chaotic, noisy classroom: children off-task
5.8	Uses a variety of 'props' to help children understand tasks	↔	Expects children to work with just numbers, no concrete support

Interviewee 6

6.1	Teaches what he is told: follows schemes closely	↔	Teaches to fit what individual children can do
6.2	Well-informed about what individual children can do	↔	Lacks skill in analysing what children do
6.3	Believes maths is very important, & spends much time on it	↔	Doesn't enjoy doing or teaching maths: spends minimum time on it
6.4	Self-confident	↔	Lacks confidence: puts self down
6.5	Serious manner: humour not used	↔	Laid-back, jovial manner
6.6	Approachable – has time for children	↔	Frightening: uses verbal put-downs
6.7	Wants children to be confident with their maths	↔	Wants children just to listen & understand straight away
6.8	Understands progression in mathematical learning	↔	Focus on getting through curriculum, rather than understanding

Interviewee 7

7.1	Constantly improves teaching skills through experiences	↔	Has not improved teaching through experience – stuck in a rut
7.2	Perceives only one way of teaching something	↔	Keeps trying different methods to find one that works
7.3	Teaches topics as an entity –doesn't think of breaking things down	↔	Breaks work down to make it easy for children to learn
7.4	Encourages child talk & activity in class	↔	Heads down, silent worksheets
7.5	Knows what she wants children to learn, designs structures to lead there	↔	Direct teaching of skills
7.6	Has empathy for pupils' problems & feelings	↔	Attributes pupil difficulties to lack of ability

7.7	Able quietly to set & maintain behavioural standards in class	↔	Finds it difficult to maintain discipline
7.8	Enthusiastic about the subject	↔	Just teaching it because they have to

Interviewee 8

8.1	Aims to understand child's thinking	↔	Believes child is not capable of understanding
8.2	Tries to match teaching method to where the child is	↔	Presents generic lessons, based on own expectations
8.3	Knows about course of children's mathematical development	↔	No understanding of children's development
8.4	Aim for children to enjoy succeeding	↔	Not bothered about how children feel
8.5	Has high expectations for children	↔	Has low expectations of children's ability
8.6	Uses questions to prompt children to analyse their own thinking	↔	Just marks things right or wrong
8.7	Makes ignorant assumptions of what children can do	↔	Assesses knowledgably & in detail what children can do
8.8	Empowers children to work confidently & independently	↔	Directs children all the time

Interviewee 9

9.1	Experienced & knowledgeable	↔	Lacks experience, so less competent
9.2	Understands how children learn	↔	Relies on age-related expectations – no idea of structure of children's learning
9.3	Assesses where children are and matches teaching	↔	Unstructured assessment, not related to subsequent teaching
9.4	Good knowledge of number	↔	Has difficulty working with number – poor subject knowledge
9.5	Enjoys working with children	↔	Not enthusiastic or tolerant – shouldn't be there!
9.6	Want to help children move forward and do their best	↔	Wants their pay, and not interested in job satisfaction or helping children
9.7	Keen to improve as a teacher	↔	Lacks motivation, not interested in the job
9.8	Teaches more able pupils successfully, but struggles to teach less able	↔	Responds to learning needs of pupils at all levels

Interviewee 10

10.1	Creative, fun way of teaching	↔	Lots of pressure to cover mounds of work
10.2	Wants children to work for themselves and reflect on what they do	↔	Wants them to sit & listen – be taught
10.3	Reluctant to speak out – inflexibly follows plans	↔	Confident, contributes to plans
10.4	Has wide range of teaching ideas	↔	Boring, uses same methods all the time
10.5	Understands mathematical vocabulary	↔	Doesn't understand mathematical vocabulary
10.6	Eager to learn about teaching	↔	Closed to new ideas
10.7	Very strict: doesn't let pupils choose	↔	Gives pupils free choice

10.8	Builds next step on child's existing understanding	⟷	Pushes children when not ready

Interviewee 11

11.1	Well organised	⟷	Not thoroughly planned
11.2	Knows how children learn	⟷	Doesn't know how children learn
11.3	Good grasp of number	⟷	Not confident with number
11.4	Talks over the children, gives no chance to respond	⟷	Receptive, relaxed, calm
11.5	Flexible, changes plans according to pupils' needs	⟷	Rigidly follows plans: loses sight of pupils' needs
11.6	Has just one way to teach each thing	⟷	Understands a range of ways to teach things
11.7	Brisk-paced lessons	⟷	Vague, sloppy, purposeless
11.8	Makes lessons fun and interesting	⟷	Lessons are stressful and difficult

APPENDIX K

THE NINE PRINCIPLES OF MATHEMATICS RECOVERY

1. The teaching approach is enquiry based, that is, problem based. Children are routinely engaged in thinking hard to solve numerical problems that for them are quite challenging.

2. Teaching is informed by an initial, comprehensive assessment and ongoing assessment through teaching. Assessment through teaching refers to the teacher's informed understanding of the child's current knowledge and problem-solving strategies, and continual revision of this understanding.

3. Teaching is focused just beyond the 'cutting edge' of the child's current knowledge.

4. Teachers exercise their professional judgement in selecting from a bank of instructional settings and tasks, and varying this selection on the basis of ongoing observations.

5. The teacher understands children's numerical strategies and deliberately engenders the development of more sophisticated strategies.

6. Teaching involves intensive, ongoing observation by the teacher and continual micro-adjusting or fine-tuning of teaching on the basis of her or his observation.

7. Teaching supports and builds on the child's intuitive, verbally based strategies and these are used as a basis for the development of written forms of arithmetic that accord with the child's verbally based strategies.

8. The teacher provides the child with sufficient time to solve a given problem. Consequently the child is frequently engaged in episodes that involve sustained thinking, reflection on her or his thinking and reflecting on the results of her or his thinking.

9. Children gain intrinsic satisfaction from their problem-solving, their realization that they are making progress and from the verification methods they develop.

From Wright, Martland & Stafford, 2006

APPENDIX L: MATHS RECOVERY QUESTIONNAIRE **Name:**

Please read both extremes of each item, and put a cross through the rating which best describes your position on that item.

1	Always uses next step from the curriculum	1	2	3	4	5	Chooses next teaching step according to child's knowledge
2	Has good knowledge of number	1	2	3	4	5	Has poor knowledge of number
3	Has confused beliefs about teaching	1	2	3	4	5	Secure in beliefs about teaching
4	Does not match teaching or tasks to child's performance	1	2	3	4	5	Teaches just beyond the 'cutting edge' of each child's current knowledge
5	Rigidly follows plans	1	2	3	4	5	Changes plans according to pupil need
6	Spends minimum time on maths	1	2	3	4	5	Believes that maths is important and should have time spent on it
7	Flexible, willing to change in order to implement philosophy better	1	2	3	4	5	Rigid, has set ways of doing thing
8	Satisfied if children have just one method to solve a problem, and they get the right answer	1	2	3	4	5	Wants children to develop verification strategies, and to have intrinsic satisfaction from this
9	Has a wide range of teaching methods, equipment and strategies	1	2	3	4	5	Has just one way to teach each thing
10	Makes unstructured observations and ignorant assumptions	1	2	3	4	5	Makes skilful assessment of what individuals actually do and know
11	Lack of interest in children's enjoyment	1	2	3	4	5	Wants children to enjoy lessons and build confidence through success

12	Sticks with usual methods, attributes failure to child and doesn't reflect on own practice	1	2	3	4	5	Experiments with teaching: tries to 'unstick' pupils with new approaches: inspirational teaching
13	Has low expectations of children's abilities	1	2	3	4	5	Expects that children will be able to understand
14	Starts form child's intuitive, verbal strategies: bases development of written methods on these	1	2	3	4	5	Starts with direct teaching of standard, written methods
15	Impatient, humourless, unreceptive	1	2	3	4	5	Patient, jovial, receptive and calm
16	Tells children how to solve tasks	1	2	3	4	5	Uses open-ended tasks, facilitation and pupil choice
17	Has poor understanding of how children learn	1	2	3	4	5	Has good understanding of how children learn
18	Has haphazard, disorganized approach	1	2	3	4	5	Structures and paces lessons well
19	Teacher assesses continuously through teaching, always revising their understanding of child's knowledge.	1	2	3	4	5	Teacher uses assessment in a static way, at fixed points in time and for summative purpose only
20	Seeks to improve as a teacher, by reflecting on new ideas	1	2	3	4	5	'Stuck in a rut', closed to new ideas
21	Uses understanding of children's numerical strategies, to help them to develop more sophisticated ones	1	2	3	4	5	Focuses on children getting correct answers: no interest in their strategies
22	Has poor discipline, chaotic classroom	1	2	3	4	5	Has good behaviour management
23	Knows about the course of development of children's learning of number	1	2	3	4	5	Does not understand children's development: relies on age-related expectations
24	Motivates children through fun and enthusiasm	1	2	3	4	5	Motivates children through pressure and fear

25	Uses questions and discussion	1	2	3	4	5	Uses silent, written work
26	Provides differentiated tasks and support whilst teaching	1	2	3	4	5	Makes rigid use of generic lessons or linear scheme
27	Disregards pupil responses, and keeps rigidly to a pre-planned course	1	2	3	4	5	Makes intensive observations of pupils whilst teaching, and continually adjusts teaching on basis of these
28	Tries hard and wants to teach number – committed to the job	1	2	3	4	5	Not interested in the job
29	Feels confident and contributes to plans	1	2	3	4	5	Feels insecure and does not contribute to planning
30	Supports children towards independent learning	1	2	3	4	5	Directs or 'spoon feeds' children
31	Teaches in didactic manner, with teacher directly transmitting knowledge	1	2	3	4	5	Teaches in enquiry based manner, with children thinking hard to solve challenging problems
32	Committed to and excited by helping children	1	2	3	4	5	Just wants their own pay
33	Derives teaching strategies from an understanding of number	1	2	3	4	5	Cannot break number work down into teachable segments
34	Empathises with children and supports them with difficulties	1	2	3	4	5	Blames them for their difficulties

Please comment overleaf on the following aspects of the questionnaire:

1. Did you understand the meaning of the items?
2. Was the layout appropriate?
3. Any other comments.

APPENDIX M

MATHS RECOVERY QUESTIONNAIRE: SUMMARY OF PRE AND POST COURSE RATINGS Name: Contact:

	Ratings before training A		Ratings After training B		Improvement	Description of Item		
Item no	Score	Adjusted score (Lower is better	Score	Adjusted score (Lower is better)	A – B (Higher is better)	(Good	V	Poor)
2		score		score		Has good knowledge of number	V	Has poor knowledge of number
11		6 -score		6 -score		Wants children to enjoy lessons and build confidence through success	V	Lack of interest in children's enjoyment
24		score		score		Motivates children through fun and enthusiasm	V	Motivates children through pressure and fear
17		6 -score		6 -score		Has good understanding of how children learn	V	Has poor understanding of how children learn
23		score		score		Knows about the course of development of children's learning of number	V	Does not understand children's development: relies on age-related expectations
1		6 -score		6 -score		Chooses next teaching step according to child's knowledge	V	Always uses next step from the curriculum
26		score		score		Provides differentiated tasks and support whilst teaching	V	Makes rigid use of generic lessons or linear scheme

10		6 -score		6 -score		Makes skilful assessment of what individuals actually do and know	V	Makes unstructured observations and ignorant assumptions
32		score		score		Committed to and excited by helping children	V	Just wants their own pay
22		6 -score		6 -score		Has good behaviour management	V	Has poor discipline, chaotic classroom
30		score		score		Supports children towards independent learning	V	Directs or 'spoon feeds' children
16		6 -score		6 -score		Uses open-ended tasks, facilitation and pupil choice	V	Tells children how to solve tasks
25		score		score		Uses questions and discussion	V	Uses silent, written work
6		6 -score		6 -score		Believes that maths is important and should have time spent on it	V	Spends minimum time on maths
28		score		score		Tries hard and wants to teach number – committed to the job	V	Not interested in the job
13		6 -score		6 -score		Expects that children will be able to understand	V	Has low expectations of children's abilities
34		score		score		Empathises with children and supports them with difficulties	V	Blames them for their difficulties
18		6 -score		6 -score		Structures and paces lessons well	V	Has haphazard, disorganized approach

33		score		score		Derives teaching strategies from an understanding of number	V	Cannot break number work down into teachable segments
5		6 -score		6 -score		Changes plans according to pupil need	V	Rigidly follows plans
20		score		score		Seeks to improve as a teacher, by reflecting on new ideas	V	'Stuck in a rut', closed to new ideas
12		6 -score		6 -score		Experiments with teaching: tries to 'unstick' pupils with new approaches – inspirational teaching	V	Sticks with usual methods, attributes failure to child and doesn't reflect on own practice
29		score		score		Feels confident and contributes to plans	V	Feels insecure and does not contribute to planning
3		6 -score		6 -score		Secure in beliefs about teaching	V	Has confused beliefs about teaching
7		score		score		Flexible, willing to change in order to implement philosophy better	V	Rigid, has set ways of doing thing
15		6 -score		6 -score		Patient, jovial, receptive and calm	V	Impatient, humourless, unreceptive
9		score		score		Has a wide range of teaching methods, equipment and strategies	V	Has just one way to teach each thing
31		6 -score		6 -score		Teaches in enquiry based manner, with children thinking hard to solve challenging problems	V	Teaches ns didactic manner, with teacher directly transmitting knowledge
19		score		score		Teacher assesses continuously through teaching, always revising their understanding of child's knowledge.	V	Teacher uses assessment in a static way, at fixed points in time and for summative purpose only

4		6 -score		6 -score		Teaches just beyond the 'cutting edge' of each child's current knowledge	V	Does not match teaching or tasks to child's performance
21		score		score		Uses understanding of children's numerical strategies, to help them to develop more sophisticated ones	V	Focuses on children getting correct answers: no interest in their strategies
27		6 -score		6 -score		Makes intensive observations of pupils whilst teaching, and continually adjusts teaching on basis of these	V	Disregards pupil responses, and keeps rigidly to a pre-planned course
14		score		score		Starts from child's intuitive, verbal strategies, and bases development of written methods on these	V	Starts with direct teaching of standard, written methods
8		6 -score		6-score		Wants children to develop verification strategies, and to have intrinsic satisfaction from this.	V	Satisfied if children have just one method to solve a problem, and they get the right answer
		Total A		Total B	Improve-ment:			

NB Items above bold line were derived from research with maths recovery trained teaching staff. Items below bold line were derived from principles documented in the Maths Recovery texts.

Personal Notes

APPENDIX N

MATHS RECOVERY QUESTIONNAIRE: SUMMARY OF PRE AND POST COURSE RATINGS: (course finishing in Spring 08)

Teacher / Teaching Assistant (please circle)

Approximate No of years experience working in this role: ....

Rating before training (Total A)...........................

Rating after training (Total B)............................

Improvement (A-B)...............

Two Most Improved constructs

....

....

Two Least Improved constructs

....

....

Any comments on how you feel you may have changed/developed, as a consequence of the experience of the course:

....

....

....

....

APPENDIX O

Table 7.5: Pre and Post scores on questionnaire for Pilot group of 69 staff

Teaching Assistant	Teacher	Years Experience	Pre- score (A)	Post-score (B)	Difference (A-B)
✓		6	57	50	7
✓		1	66	54	12
✓		6	70	41	29
	✓	25	43	36	7
	✓	20	85	68	17
✓		15	68	55	13
✓		10	100	73	27
✓		11	60	49	11
	✓	5	81	52	29
	✓	14	78	55	23
✓		25	52	52	0
	✓	7	57	45	12
✓		6	62	54	8
	✓	2	74	47	27
✓		8	76	53	23
✓		2	81	69	12
	✓	20	72	56	16
✓		10	61	51	10
✓		3	59	51	8
✓		4	80	56	15
	✓	3	88	63	25
✓		3	80	74	6
✓		3	75	59	16
	✓	34	52	46	6
	✓	25	80	60	20
	✓	3	65	53	12
✓		17	79	40	39
	✓	15	63	43	20
✓		2	73	62	11
✓		2	70	71	-1
	✓	20	94	79	15
	✓	8	77	79	2
✓		10	60	39	21
✓		5	91	65	26
✓		9	88	58	30
	✓	13	64	39	25
	✓	5	76	61	15
✓		6	57	36	21
	✓	3	73	57	16
	✓	25	75	56	19
✓		8	35	25	10

Teaching Assistant	Teacher	Years Experience	Pre- score (A)	Post-score (B)	Difference (A-B)
	✓	12	72	59	13
✓		8	72	51	21
✓		2	84	56	28
	✓	2	58	44	14
✓		8	60	47	13
	✓	8	57	36	21
	✓	20	69	63	6
	✓	10	55	34	21
✓		7	78	34	44
✓		9	97	34	63
✓		12	74	34	40
	✓	11	53	36	17
✓		12	65	62	3
	✓	2	67	48	19
✓		8	67	42	25
✓		20	80	56	24
✓		8	42	22	20
	✓	2	67	49	18
	✓	7	69	60	9
	✓	2	79	70	9
✓		4	85	77	8
	✓	30	85	67	18
	✓	20	57	44	13
✓		3	50	36	14
✓		3	96	76	20
	✓	3	51	47	4
	✓	16	88	84	4
	✓	20	89	89	0
No of TAs 36	No of Ts 33	Mean	Mean 70	Mean 52.9	