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**Thesis**

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A Case Study Exploration of Primary Teachers' Conceptions of Whole Class  
Interactive Mathematics Teaching

Submitted for the Degree of Doctor of Philosophy  
At the University of Northampton

2012

Judy M Sayers

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I love you, not for what you are, but for what I am when I am with you.

...you are helping me to make of the lumber of my life not a tavern but a temple;  
out of the works of my every day not a reproach but a song.

...You have done it ...by being yourself.

Perhaps that is what being a friend means, after all.

Anon.

## Abbreviation list

These abbreviations are used within the thesis:

|        |  |
|--------|--|
| APP    | Assessing Pupils Progress                              |
| AST    | Advanced Skilled Teacher                               |
| BA     | Bachelor of Arts                                       |
| BERA   | British Educational Research Association               |
| CD     | Compact Disk   |
| CN     | Classroom Norms  |
| CPD    | Continued Professional Development                     |
| DfEE   | Department for Education and Employment                |
| DfES   | Department for Education and Skills                    |
| DVD    | Digital Versatile Disk                                 |
| ICT    | Information and Communication Technology               |
| ITE    | Initial Teacher Education                              |
| ITT    | Initial Teacher Training                               |
| KS1    | Key stage one (5-7yrs)                                 |
| KS2    | Key stage two (7-11yrs)                                |
| KS3    | Key stage three (11-14yrs)                             |
| KS4    | Key stage three (14-16yrs)                             |
| LMT    | Leading Mathematics Teacher                            |
| METE   | Mathematics Education Traditions in Europe (2003-2005) |
| MI     | Mathematical Intent                                    |
| NLS    | National Literacy Strategy (1998)                      |
| NNS    | National Numeracy Strategy (1999)                      |
| OfSTED | Office of Standards in Education                       |
| PA     | Pedagogical Approach                                   |
| PCK    | Pedagogical Content Knowledge                          |
| PhD    | Philosophiae doctor (Latin) Doctor of Philosophy       |
| PNS    | Primary National Strategy (2003)                       |
| QCA    | Qualifications and Curriculum Agency                   |
| QCDA   | Qualifications and Curriculum Development Agency       |
| OMS    | Oral mental Starter                                    |

|       |   |
|-------|---|
| QTS   | Qualified Teacher Status                      |
| SCK   | Subject Content Knowledge                     |
| SKITT | School Centred Initial Teacher Training       |
| SMT   | Senior Management Team                        |
| SR    | Stimulated Recall                             |
| SRI   | Stimulated Recall Interview                   |
| WCI   | Whole Class Interaction                       |
| WCIT  | Whole Class Interactive Teaching              |
| ZPD   | Zone of Proximal Development (Vygotsky, 1962) |

## **Abstract**

A Case Study Exploration of Primary Teachers' Conceptions of Whole class Interactive Mathematics Teaching.

Judy Sayers

Research has shown, with respect to the learning of mathematics, that whole class interactive teaching, its form and function, is a complex phenomenon. Teachers develop and exploit pedagogical strategies, which they believe are effective either in engaging their children in mathematical learning or in presenting mathematics to learners. Such strategies, whether later shown to be effective or not, are typically assumed to develop during periods of teacher education or through practice after qualification. Alongside these assumptions is the belief that teachers who are enthusiastic about and have a secure subject knowledge with respect to mathematics will evoke similar enthusiasm, confidence and competence in their learners.

However, observations during my years as a teacher educator have led me to conclude that trainee teachers, even those with similar qualifications, frequently behave very differently when put in front of children. Such differences confound the naïve assumption, for example, that similar enthusiasm and confidence will yield similar patterns of teaching practice. Thus, what primary teachers do and why they do it has vexed me for a number of years. I have wanted to know, in particular, what makes teachers teach differently during whole class episodes, not least because my experiences as both teacher and teacher trainer have led me to believe that it is during these periods that teachers induct their children into those mathematics-related beliefs and behaviours that will determine the extent to which they enjoy and engage meaningfully with the subject.

Addressing such questions demands an appropriate methodological stance. Consequently an exploratory case study of six teachers, two during a first, essentially pilot phase, and four during a second, was undertaken. All teachers, to facilitate understanding of how exemplary practice differs from one person to another, were considered, against various criteria, as effective. The pilot enabled me to evaluate not only the effectiveness of extant frameworks for analysing classroom behaviour but also my skills as an interviewer and observer of classrooms. The second phase, drawing on what had been learnt during the first, was more open in that existing frameworks were abandoned in favour of allowing the data to speak for

themselves rather than being constrained by others' conceptualisations of effective teaching. Both phases, to examine teachers' underlying beliefs about mathematics and its teaching, their classroom practice, particularly during whole class episodes, and their rationales for their actions, were addressed by means of a battery of data collection tools.

Teachers' backgrounds and underlying beliefs about mathematics and its teaching were examined through preliminary, life history, interviews framed by a loose set of questions derived from the literature. Interviews were video-recorded. Teachers' classroom actions were captured by means of a tripod-mounted video camera placed discretely in their classrooms, augmented by a wireless microphone worn by the teacher and a separate, static microphone to capture as much of the children's talk as possible. Finally, teachers' rationales and explanations for their actions were examined through the use of video-recorded video stimulated recall interviews. All recordings, whether of classrooms or interviews, were transcribed for later analysis.

Analysis during the first phase drew extensively on pre-existing frameworks. While they were helpful in identifying both similarities and differences in teachers' beliefs, actions and rationales, it became clear that they failed to capture the subtleties and nuances of meaning embedded in the high quality data yielded by the approaches adopted. In so doing it became clear that while data collection approaches were appropriate, analyses needed to be more open in order to allow the data to give up the depth and complexity of their stories. During the second phase, while it was acknowledged that this was not a grounded theory study, analysis drew extensively on the coding strategies of the constant comparison procedures of grounded theory. This approach to analysis yielded results previously unknown in the literature.

Quite unexpectedly two groups emerged from the data. Significantly, each was underpinned by teachers' experiences as learners of mathematics and whether the enjoyment they had gleaned from those experiences was instrumentally located or relationally located. The first group, identified as the *mediators*, having been engaged, in various ways, with mathematics and derived pleasure from relational experiences expected their children to experience mathematics similarly. Their teaching was based on a desire to develop, in collaborative ways, a deep conceptual knowledge that would form the basis for later procedural skills and, significantly, problem solving. Teachers in the second group, identified as the *mediated* group, having derived pleasure from their procedural successes as children, saw

mathematics and its teaching as skills-based. Their classroom actions and commensurate rationales were focused on surface learning and the replication of the pleasure they had experienced when young.

Interestingly, the beliefs of both groups and, to an extent, their classroom actions were independent of any training they had received. The *Mediators* showed different signs of professional independence and autonomy. They had a clear articulation of their warranted principles and were able to exploit these in the ways that mediated the constraints within which they worked. Moreover, and this presents substantial implications for teacher education, teachers in the *Mediated* group, exhibited few signs of professional independence; their actions being constantly mediated by the constraints, whether institutional or governmental, within which they worked. They had few articulated principles around which they based their teaching. These differences permeated all aspects of their work.

# **Chapter 1 Introduction**

This thesis is concerned with the investigation of whole class interactive primary mathematics teaching. It is a multiple case study, in two phases, of six teachers. The introduction of the National Numeracy Strategy in 1999 was an unprecedented development in primary mathematics which directed, nominally voluntarily but de facto compulsorily, teachers to engage in whole class interaction e.g. develop children's mental calculation strategies through 'direct teaching' (DfEE, 1999, p12-13) in a three part lesson. It is this area of 'direct teaching' that is investigated here through teachers' espoused and enacted beliefs about mathematical learning. In this chapter I outline the rationale for the study, the overarching research aim and objectives of this and an overview of each chapter.

## **1.1 Starting point and background**

Once my own children were established in school I worked as a classroom assistant for three years before training to be a primary teacher. During this time part of my role was to assist with the marking children's work, particularly in mathematics lessons. I became aware that many children in classes I supported did not enjoy mathematics, although their opinion, often changed as they moved to another teacher with their year group. The teachers I worked with appeared to have different styles of teaching mathematics; some appeared to really enjoy the subject whereas others talked about mathematics as just something else they were required to teach. After conversations with my own children's teachers regarding particular mathematical concepts for example, when my son struggled with fractions, his teacher indicated that it was quite normal and she too had struggled with fractions, and everybody does to some degree. When my son moved to the next year group with a different teacher, his struggling with fractions disappeared. It became clear to me that different teachers exploit a variety of approaches to mathematics teaching; sometimes they changed their approach to suit the concept taught. For example, some teachers used practical work when doing shape, space and measurement, but very little when teaching number; others used practical approaches when teaching all concepts, while others just seemed to use the next worksheet from their collection.

Later during teacher training and beyond as both a Key Stage one (KS1) and two (KS2) teacher, I began to develop different strategies as I grew more confident in my role,

recognising that some topics in mathematics were more difficult to grasp than others. I also realised that some colleagues found particular topics difficult to teach whereas others were more confident. I noticed that some teachers who were enthused by mathematics were not always successful in evoking the same in their children whereas teachers, who appeared to dislike the subject and talked about a lack of confidence, were able to produce confident and successful students. This aspect I found intriguing and it sparked an interest in the way in which teachers presented the subject to their students. The schools I had worked in were well resourced with at least two different schemes of text books to draw on as well as the many materials developed by the National Numeracy Strategy (NNS) (DfEE, 1999) and later the Primary National Strategy (PNS) (DfES, 2003). Through observing colleagues in whole class interaction it appeared to me that it was the whole class phase that played a significant influence on how children learnt and became confident in the subject, and bearing in mind the increased emphasis on 'direct' NNS, (DfEE, 1999) teaching in government guidance materials, I embarked on this aspect of research into teaching mathematics in primary schools.

An initial investigation into the literature of whole class interaction teaching (WCIT) soon revealed a very wide perspective from areas such as *classroom discourse* where communication and language issues are investigated, e.g. Cazden, (2001); Pimm (1987; 1995); Herbel-Eisenmann et al. (2010); Houssart (2001), Sherin (2002); the relationship between *beliefs and practice* as described by Thompson (1984), Beswick (2005); and Carpenter and Lubinski (1990), to the impact of *teacher's subject knowledge* and its effect on children's learning, such as those reported by Leikin and Levav-Waynberg (2007); Ma (1999); Rowland and Ruthven (2011). Other foci presented themselves in the literature, but, due to there not being reported as influencing teachers' conceptions of whole class teaching, were consequently discarded. For example, *teacher resources* imply such a multitude of items, from a pencil to a teacher's qualifications, that the whole focus of the study could be skewed. This is not to say I would not consider reporting on the resource a teacher uses, for example, the software on an interactive whiteboard or a set of digit cards, but I am more interested in how a teacher uses that resource to present mathematical concepts; whether the teacher demonstrates or models the concept with the resource, and what justification they present for that decision. What informed their decision, was it informed by their subject or pedagogical content knowledge of the subject? Was it informed by their perspectives on the nature of mathematics? It seemed to me, as both a teacher and teacher

trainer, that teachers' *actions* and *talk* and their decisions about these at both the planning stage and in the whole class interactive moment, may be a more fruitful direction for reviewing the literature to inform this study.

Indeed, the literature provided some interesting and important insights with regard to what teachers do in WCIT phases, but little is offered on a teacher's perspective on this. In fact Chazan and Ball (1999) suggested that the mathematics education community needed to improve its understanding of the complexities related to the decisions teachers make. Just as Herbel-Eisenmann et al. (2010) discussed 'little has been done to try to better understand authority and positioning issues in mathematics classrooms' (p11) in which teachers operate. Consequently this research aims to provide insight into what those issues might be for practising teachers in mathematics lessons, and how they impact on a teacher's point of view.

## 1.2 Aims of the Study

The broad aim of this study is to undertake an in-depth investigation of teachers' beliefs about and actions in the whole class direct teaching phases of primary mathematics lessons. In order to achieve this aim three research objectives are proposed:

1. To investigate the mathematics-related didactical beliefs and backgrounds of practising primary teachers
2. To capture and analyse the ways in which practising teachers enact the whole class interactive teaching phases of mathematics lessons
3. To investigate teachers' perspectives on and professional decisions relating to those captured lessons.

## 1.3 Overview of the thesis

The thesis comprises of eleven chapters. A review of the literature on the influences that can impact on the teaching of mathematics in general, but in whole class interactive phases in particular will be investigated in chapter two. Speer (2005) reported that very little has been recorded about what teachers think or believe to be happening in this phase of a lesson, therefore a wider review is necessary in the field. There are two research areas that were identified as influential in the teaching of mathematics: a teacher's beliefs and attitudes towards the subject and its teaching, and the act of whole class teaching approaches. Both areas are explored in this chapter (sections 2.1 and 2.2).

Chapter three explicates the theoretical foundations of the study in general and the arguments for a multiple case study methodology and approach in particular. In so doing, I examine a set of analytical tools the literature has shown to be effective in helping us understand mathematics classrooms.

Chapter four presents and discusses the first phase of the study. This was an in-depth analysis of two teachers' beliefs and practices and an opportunity to examine the efficacy of the tools discussed in chapter three. The two teachers, considered locally to be effective, were the mathematics coordinator for their schools. The outcome of this phase facilitated the refinement of both data collection and analysis.

Chapters five to eight present the four primary teachers cases. The analysis and discussion is presented in chapter nine where each case data is analysed against the literature and across the cases. The discussion is presented in three sections: Mathematical Intent; Pedagogical Approaches and Classroom Norms. These sections are explained and developed to inform a theoretical stance on the issues derived from the data in chapter ten. The chapter summarises three significant key aspects to inform the research field, some of which are new, others provide new insights, retelling old insights, in a new way that inform the necessary reprofessionalisation of teachers.

Finally chapter eleven revisits the research questions and summarises the outcomes of the two phases of the study. I consider the limitations of the study and discuss its implications for future research and policy makers. I conclude with a personal reflection on the whole PhD journey.

## Chapter 2 Literature review

The research review that follows highlights and discusses the issues I need to consider as I shape my investigation into how a primary teacher conceptualises the whole class interactive teaching episode(s) in their mathematics lesson. I will identify and clarify the research questions on which this study will be based, drawing from three perspectives: research, professional (e.g. teachers' handbooks and journals) and governmental guidance (e.g. PNS. DfES, 2003 and NNS. DfEE, 1999, materials).

### 2.1 Introduction

When considering the complexities of observing the interactions between a primary classroom teacher and her class, against a teacher's conceptual understanding of these events one has to acknowledge the vast amount of research that has already accumulated on what 'teaching' and in particular 'mathematics teaching' might be. For example Stigler & Hiebert (1997) write that teaching is 'rooted in deeply held beliefs about the nature of the subject, the way students learn, and the role of the teacher (1997, p19). According to research, a major influence on the ways in which teachers implement the intended curriculum concerns their beliefs about the nature of mathematics and its curricular justification. Indeed, teacher's conceptions of mathematics and its teaching 'play a significant role in shaping the teachers' characteristic patterns of instructional behavior' (Thompson, 1992, p130-131).

Research has also shown that the environment teachers create, which Malaguzzi (1998) has described as the 'third teacher', impacts significantly on children's learning. The classroom environments that teachers create, informed by the pedagogic traditions within which they operate, are culturally located to the extent that the mathematics teaching found in the classrooms of one country has characteristics that distinguish it from another (Andrews 2009a, 2009b; Alexander 2000; Schmidt et al. 1996). Moreover, there is evidence to suggest that pedagogic traditions vary between the regions of a country (Andrews & Hatch, 1999; Leung et al. 2005; MacNab & Payne, 2003). If this is the case then it is likely that individual schools may engender a specific and unarticulated pedagogic tradition (Sayers, 2007). It could be argued that teacher beliefs, as antecedents of their professional identities, impact on the environments they create for their students, thus each teacher will evoke their own 'classroom culture' or even 'mathematics classroom culture'.

The construction and manifestation of teachers' professional identities have been extensively researched for example: Connelly and Clandinin, 1999; Day et. al., 2006; Grossman and Stodolsky, 1995); Hirsch, 1993; Smit & Fritz, 2008). Their research shows that identities are informed by individuals' biographies which, for teachers of mathematics, draw substantially on their relationship with the subject and their experiences of schooling (Fieman-Nemser and Buchmann, 1986; Foss and Kleinsasser 1996). In this respect, Andrews' (2007a) study highlights well the interrelationship between teachers' biographies - including their experiences of and attitudes towards mathematics - and the environments they create for their students.

Within education in general and in particular the field of classroom observation there is much research on how teachers teach mathematics and how they structure their lessons (Ball 1993; Cobb & Hodge, 2011; Galton et al. 1999; Lampert, 1986). There is also much research (Barwell, 2005; Cazden, 2001) on the discourse created by teachers and their pupils including particular phrasings, as well as an analyses of teacher's gestures (Arzarello et al. 2006, 2009; McNeill, 2000, Rasmussen et al. 2003) and classroom management issues such as groupings used (Evertson and Weinstein 2006; Jones and Jones 2006; Jones & Jones, 2012; McNamara 1994; Muijs and Reynolds 2001). Although Golafshani (2002) examined teachers' conceptions about the nature of mathematics and its influence on their teaching, very little has been reported on what teachers think or believe to be happening when they are conducting whole class episodes within their mathematics lesson(Speer 2005).

This study therefore, is unique in the field of a primary teacher's conceptual understanding by drawing on the perception of what a teacher does in whole class interaction in their mathematics lesson.

When analysing the literature there is much evidence to suggest that one's experiences as a learner of mathematics, one's conceptions about the nature of mathematics and one's instructional practices as a teacher of mathematics are all profoundly interconnected (Lerman 1990; McNamara et al. 2002; Meredith 1993; Sanders 1994; Thompson 1984). The implication of this is to look at these particular areas in detail to draw out what those connections are in order to identify what influences a primary teacher during planning and teaching their whole class interactive teaching phase of a mathematics lesson. Moreover, there appear to be two threads or themes running through these issues highlighted above. The first relates to teacher cognition and includes, for example, teacher knowledge, teacher

beliefs and attitudes, and teacher's identity. The second, essentially pedagogical, concerns teachers' practice in respect of whole class interaction and includes, for example, classroom communication, classroom discourse, critical moments and teacher actions.

### **Theme one: Cognitive**

- **Teacher knowledge about the subject: mathematics**
- **Teacher beliefs and attitudes towards the subject and the teaching of the subject: mathematics**
- **Teacher identity**

### **Theme two: Pedagogical**

- **Communication and interaction**
- **Classroom discourse**
- **Critical moments**
- **Teacher actions**

I will now present a review of the literature related to each theme identified in the research field.

## **2.2 Theme One: Cognitive**

### **2.2.1 Teacher knowledge about the subject: mathematics**

Research has shown that a teacher's subject knowledge is a key determinant in his or her confidence as a teacher of mathematics (Goulding et al. 2002; Goulding and Suggate 2001; Petrou & Goulding, 2011). Aspects of this relationship include, for example, the relationship between subject knowledge quality and a teacher's ability to question effectively (Rowland et al. 2000). Recently, teachers' subject knowledge has been the subject of government concern, as 'teachers may not have the subject knowledge needed to identify links and connections within mathematics or with the wider curriculum' (Qualifications and Curriculum Authority (QCA) 2005, p9). In sum, teacher subject knowledge appears to be a crucial aspect of mathematics teaching. Therefore, in the following I analyse the literature further, with the view to highlighting the significance of subject knowledge in the construction of a teacher's professional identity and practice.

It can be argued that part of teaching a subject is to have knowledge of that subject (Aubrey 1997; Buchmann 1984; Murphy 2006; Turner & Rowland, 2011). As Ball (1991) points out, it seems intuitive that the 'more one knows about one's subject, the more effective one can be

as a teacher' (p3); that without knowledge a teacher '...simply cannot teach anything'(McNamara 1991, p124). It could also be argued that there is more to teaching than just 'knowing' something about a subject. Teaching is a complex social activity requiring knowledge about many aspects related to cognitive progress and pedagogy, which will be discussed later in the chapter, together with the ability to manage and focus a large group of children with a range of attainments. I will now identify in the literature what teacher knowledge might be.

Shulman (1986) identified three domains of teacher knowledge which, although not specific to mathematics, are relevant and need to be considered when examining teacher subject knowledge. These are subject matter content knowledge, pedagogical content knowledge (later known as PCK) and curricular knowledge. Subject matter content knowledge is defined as 'the amount and organisation of the knowledge *per se* in the mind of the teacher' (p9) and pedagogical content knowledge as 'the most powerful analogies, illustrations, examples, explanations and demonstrations-in a word the ways representing the subject which makes it comprehensible to others' (p9). Shulman (1986) proposed that pedagogical content knowledge 'blends' the content and pedagogy into a knowledge of the subject that is unique to teaching. Finally, Shulman writes of curricular knowledge, or a teacher's awareness (or knowledge) of alternative curricular materials in order to present mathematics.

With respect to pedagogical content knowledge Ma (1999) examined US and Chinese elementary (primary) teachers. She found not only fundamental differences in the teachers of the two countries but also that 'a teacher's subject knowledge of school mathematics is a product of the interaction between mathematical competence and concern about teaching and learning mathematics' and that 'the quality of the interaction depends on the quality of each component' (p146). This is a useful perspective in relation to this study as part of my research will be to analyse the impact of a teacher's belief on their teaching.

Nonetheless, Murphy (2006) suggests that teachers of primary mathematics 'need to know and understand the subject in a different way to the subject specialist' (p229). Others have indicated that primary teachers are expected to know and understand mathematics in the same way and often as in-depth (An et al. 2004) as secondary teachers. Moreover, in the U.S. Ball (1990) emphasises that a teachers' knowledge of mathematics should be of sufficient depth to enable them to represent it in a variety of ways and to be flexible enough to enable them to interpret students' ideas and address misconceptions. Such findings

indicate that perspectives on the nature of mathematical knowledge and its pedagogical implications differ from one cultural context to another, although the consensus seems to be that PCK demands that teachers understand more than just concepts and procedures; it also requires an understanding of underlying principles and meanings and the appreciation of connections between mathematical ideas and structure. This certainly implies a more comprehensive view of mathematics teaching than the QCA's (2005) described earlier.

How then can we define these ideas to clarify meaning? Ma (1999) writes that a teacher needs 'an understanding of the terrain of fundamental mathematics that is deep, broad and thorough' (p121). In so doing she not only writes that *deep* mathematical knowledge is a *connected* knowledge but also that 'depth' requires connections with more conceptually powerful ideas, 'breadth' requires connections with concepts of similar power and 'thoroughness' represents 'the capability to 'pass through' all parts of the field – to weave them together' (p121). Similar ideas were proposed earlier by Askew et al. (1997), counter to Murphy's (2006) later suggestion, and confirm that primary teachers *do* need the deep understanding of mathematical structures of the specialists. Interestingly, Murphy acknowledges Ma's point that primary teachers need to know the mathematics children will meet later on and are not, as Grossman et al. (1989) report, managing their teaching by being a few pages ahead of their children.

Other studies, echoing these sentiments, recognise the link between a teacher's level of qualification and their students' achievement (e.g. Ball, 1991), although some have shown that a high level of qualification indicates neither adequate subject knowledge nor effective teaching of mathematics (Askew et al. 1997; Care and Ernest, 1993). This debate will perhaps never be resolved, although the evidence continues to point to the need for in-depth, flexible and connected subject knowledge. Indeed, in some European countries it is a mandatory entry requirement for teacher education, be it primary or secondary, as in, for example, Hungary (Andrews and Hatch 2000) and Finland (Laukkanen 2008; Niemi & Jakkusi-Sihvonen, 2006; Simola, 2005; Tuovinen, 2008). Alas in England there seems to be little consensus on the role that knowledge of mathematics beyond the level being taught may have. The DfEE (1998) proposed that the content of subject knowledge be drawn from KS3 and KS4 curriculum, including knowledge of the arithmetic laws and the number system. However, no rationale is offered, merely links with the KS1 and KS2 curriculum and a requirement that all teachers (including primary teachers) need to pass a timed competence 'skills test' in number and handling data.

The relationship between trainee teachers' subject knowledge as assessed by audit and their performance in the primary mathematics classroom was researched by Goulding et al (2002). The study found that poor audit-highlighted subject knowledge was associated with weaknesses in the planning and teaching of primary mathematics. However, they make no causal claim. Thus one is drawn to ask, how does the knowledge demonstrated in the audit inform the trainee teachers' subject knowledge for teaching primary mathematics? Their study raises many interesting issues concerning teacher training and the development of trainees' subject knowledge, but that is not for this study. However, an important point to emerge from Goulding et al.'s (2002) work is that if trainee teachers hold an impoverished view of mathematics then it is likely to be the same for practising teachers, a conjecture highlighted by several comparative studies examining, *inter alia*, mathematics teaching in England (Andrews 2009a, 2009b; Jennings and Dunne, 1996, Kaiser 2002; Kaiser et al. 2006; Sayers 2007).

The points raised above indicate that subject knowledge impacts on teachers' confidence and ability to develop their students' understanding of the subject. Shulman's (1986) domains of knowledge may prove problematic for my study in that they do not address the relational nature between knowledge and social context. For example, Bohl and van Zoest (2002) write that many of the 'bases for teachers' everyday participatory decisions are fully socially connected and value based, and fall outside of what one might term 'objective knowledge' (p4). This implies a link between knowledge, context and teachers' values, reiterating the two important themes around which I have structured this chapter, and more importantly, informing research questions. I will explore the relationship between *context* and whole class interaction later in this review, but want to continue to investigate teachers' value base through their beliefs and attitudes and identity.

### **2.2.2 Teacher beliefs and attitudes towards the subject and its teaching**

A number of studies have highlighted the influence personal experience has on teachers, primary and secondary, and measure of their classroom achievements , including the examinations of their students (Dickinson et al. 2004; Leinhardt 1988). In family attitudes to education in general and mathematics in particular have been shown to influence teachers' personal attitude to the subject (Reynolds and Walberg 1992).

Ernest (1988; 1989) believes that teachers' perceptions of mathematics resides in their belief system and, in particular, their conceptions of the nature of mathematics and mental models

of teaching and learning the subject. He also argues that although subject knowledge is important, it is not sufficient by itself to account for the differences between mathematics teachers. For example, virtually all teachers can multiply multi-digit numbers, but many teachers cannot explain the basis for multi-digit multiplication using place-value concepts and the underlying properties for adding and multiplying (Kilpatrick et al. 2001), even though they might use and teach this. Many teachers, particularly in England (Andrews, 2007a) are reported to hold a more traditional conception of mathematics, emphasising the mastery of symbols, skills and procedures, whereas others have a non-traditional conception of mathematics emphasising exploration and problem solving.

According to Ernest (1989), the practice of mathematics teaching depends on a number of elements, not simply a question of tradition. He identifies three key elements:

1. the teacher's mental contents or schemas, particularly the system of beliefs concerning mathematics and its teaching and learning;
2. the social content of the teaching situation, particularly the constraints and opportunities it provides;
3. the teacher's level of thought processes and reflection.

In the following I consider these three elements from the perspective of a typical English primary teacher. Firstly, assuming it's a woman, she is likely to be an education graduate or a graduate of a subject area in which mathematics plays little or no part. Importantly, research tells us that trainee teachers' typically commence their professional courses with strongly held beliefs, typically formed in childhood, about the nature of mathematics and its teaching that may be difficult to change (Richardson, 1996). A number of possibilities in this respect spring to mind. For example, she may have only vague memories of school mathematics and these are likely to be dominated by procedurally focused experiences. In such cases, particularly if the procedural learning was successful, trainees have difficulty accepting the validity of alternative, pupil-centred, practices (Kaasila et al 2008). She may have had very negative experiences of school mathematics, leaving her with negative attitudes that will underpin her reaction to mathematics as a teacher. Indeed, Gellert (2000) writes that trainees who experienced failure at school may develop beliefs and practices focused on protecting their students from the pain they experienced as learners. Admissions statistics from my own institution show that fewer than two per cent of PGCE and GTP have a mathematics degree. Fewer than ten per cent of the undergraduate cohort elect to study mathematics as their main (specialist) subject and, of these, only sixty per cent have an A level in mathematics. This is an institution rated highly by the inspectorate, consequently

there is no reason to assume that these proportions will be higher anywhere else, and yet the level of mathematical qualification across the teacher education suite of courses is low. Thus, in sum, it would not be unreasonable to assume that most trainees commence their course with pre-formed attitudes towards mathematics unlikely to be conducive to teaching to promote learning.

Secondly, a typical primary mathematics classroom will probably consist of not only the teaching of a particular concept or procedure, it will also be, as research has shown, influenced by social interactions, clarifications, conceptual adaptation, generation of communication channels and interpretation routines (Bruner, 1986; Lave, 1988; Newman et al., 1989; Rochelle, 1992; Vygotsky). This suggests that every learning situation can offer learners a range of positive and negative *constraints* and opportunities. Children will have learnt a behaviour which they are implicitly expected to follow for the time they are with a particular teacher (Brok et al. (2005)). This is where, as a class progresses through the year, children develop ideas about their emerging relationship with their teacher. There is a gradual stabilisation of perceptions applying equally to the teacher and the children (Blumenfeld and Meece, 1985; Doyle, 1986). These processes will be described in more detail later in section (2.2.3). Many of these *opportunities* and *constraints* are directly related to a teacher's belief about teaching and interaction expectation within her classroom environment. For example Thompson (1984) highlighted the complexities of the relationship between conceptions and practice and how they defy 'the simplicity of cause and effect' (p119). Yet much of the contrast of her three case study teachers' 'instructional emphases were presented and explained by differences in their prevailing views of mathematics' (p119). In contrast, if one turns to the work of Lerman (1990), it may be that teachers' beliefs about the nature of the subject are more influential on their practice than their mathematical subject knowledge, as Askew et al. (1997) report.

Finally, Thompson (1984) reported, for example, that a consistency between a teachers' professed conceptions of mathematics and the ways in which they were aware of the relationships between their beliefs and their practice, the effect of their actions on the students, and the difficulties and subtleties of the subject matter. She writes (p123) that

'These differences seemed to be related directly to differences in the teachers' reflectiveness – in their tendency to think about their actions in relation to their beliefs, their students, and the subject matter'.

An interesting conclusion is that the conceptions teachers possess about teaching were found to be general rather than specific to the teaching of mathematics (Thompson 1984). Golafshani (2002) discusses the same point and concludes that whatever one's conception of mathematics it affects one's conception of how it should be presented. Drawing on Hersh (1986) she writes that 'one's manner of presenting it is an indication of what one believes to be most essential... The issue, then, it is not, what is the best way to teach? but what is mathematics really about?' (Hersh 1986, p29) in Golafshani (2002).

Pajares (1992) discusses the importance of addressing teachers' beliefs in order to improve preparation and practice, as beliefs may be the clearest measure of a teacher's professional growth (Kagan, 1992). Conversely, Warfield et al.(2005) argue that the relationship between 'teachers' beliefs and their instruction is not as direct as sometimes thought' (p442). They go on to stress that it is not unusual for individuals to hold contradictory beliefs, thereby making it difficult to determine how particular beliefs influence practice, as (Pajares (1992) discusses. This is an important point and one which is not often presented in mathematics research. Nevertheless, one could argue that all these elements are part of a teacher's evolution in how well they reflect upon what they do in the classroom.

As a construct, beliefs do not appear to lend themselves easily to empirical investigation, for 'we may not be the best people to clearly enunciate our beliefs' since they 'may lurk beyond ready articulation' (Munby 1982, p64). That is, beliefs are, essentially, accessible only by inference (Da Ponte 1994; Fenstermacher 1978, p65; Green 1971). Green (1971) informs us that we organise beliefs into systems within which are primary and derivative, and central and peripheral, beliefs, and therefore, beliefs comprising a system are neither entirely independent nor equally susceptible to external influence. As Da Ponte (1994) comments 'belief systems do not require social consensus or even internal consistency making it possible not only for a belief system to be held in isolation of others but also for individuals to hold apparently conflicting beliefs' (Green 1971). If like Green (1971) we take a methodological perspective, beliefs are manifested at the level of the system then research is better focussed on the study of belief systems than on isolated beliefs (Op 't Eynde and De Corte 2003). Despite apparent clarity in respect of belief structures, there remains much ambiguity in respect of definition (Pajares 1992).

Interestingly Warfield et al (2005), like Thompson (1984), write that there is evidence that reflection mediates between beliefs and practice. I will, therefore, assume that teachers'

mathematics-related beliefs systems will draw on beliefs about mathematics teaching, beliefs about themselves as teachers and beliefs about the classroom context. It will be relevant to ask participant teachers to articulate these elements, if they can, as beliefs are seen here, in general, to be ‘subjective, experienced based, often implicit knowledge’ (Pehkonen and Pietilä 2003). Indeed Thompson (1984) highlighted the importance of ‘differences in the teachers’ reflectiveness in their tendency to think about their actions in relation to their beliefs, their students, and the subject matter’ (p123). Others, for example, Cobb (1990) and Fennema (1996), found that teachers only changed their beliefs when reflecting on problems encountered in the classroom.

The importance of identifying a teacher’s belief and attitude towards mathematics clearly has an important role in observing a teacher’s practice. However, a teacher’s identity may also impact on the way she teaches, which may be as a consequence of the way in which she sees herself as a teacher. A teacher’s ‘professional self’ will now be discussed.

### 2.2.3 Teacher Identity

What is or what constitutes a teacher’s identity? Dewey (1938) pronounced that it was constructed by a teacher’s life experience, going so far as to say, to understand a teacher’s identity, one must understand the teacher’s life. This was supported by Connelly & Clandinin (1999) who suggest that ‘our identities are composed and improvised as we go about living our lives embodying knowledge and engaging our contexts’ (p4). Our stories and experiences are the narrative expressions of who we are in our worlds, therefore to research a teacher’s understanding of the teaching of mathematics, one must research individual teachers and their understanding of their interaction with mathematics, their learning experiences and teaching experiences (Day et al. 2006; Grossman & Stodolsky, 1995; Hirsch, 1993; Smit & Fritz, 2008).

Wenger (1998) has argued that we all belong to several *communities of practice* at any given time. For example, family members develop their own practices, routines, rituals and activities and work hard to keep these in place. Workers organise their lives within their community in relation to their colleagues and their customers to make sure their ‘job’ or ‘work’ is done effectively. In so doing they develop sets of procedures and expectations. In education, too, a teacher will develop a range of management activities characteristic of her practice. Children learn and follow these expected procedures, just as the class does within their broader school setting and their wider community. Importantly, the quality of any

interaction will reflect the degree to which people involved form a community (Dewey 1938). How a teacher experiences her job, how she interprets her position, how she understands what she teaches, what she knows, what she does not know and what she does not ‘try’ to know; all these are neither simply individual choices nor simply the result of belonging to the social category ‘teacher’. Instead, they are negotiated in the course of doing the ‘job’ and interacting with others. Moreover, through such participation we acquire our identity (Wenger 1998). To develop a practice, therefore, requires the formation of a community whose members engage with one another and thus acknowledge each other as participants within that community. In sum, despite a number of incommensurate constructs developed within the broader notion of identity (Cummins 1996; Norton 2000; Wenger 1998), I intend the term ‘identity’ to mean how a person understands his or her relationship to the world, ‘how the relationship is constructed across time and space, and how the person understands possibilities for the future’ (Norton, 2000, p5).

To summarise, one must consider, as a consequence, that practice involves the negotiation of ways of being a person in ‘context’ (Clarke 2001). The negotiation of meaning by participating with others in different situations and different activities makes us who we are. In my study I must not ignore how reciprocal relationships between people’s experiences of the world, in this case a teacher’s experience, shape their world and form the very essence of who he or she is. A teacher’s identity is, in the biggest sense, the who-we-are that develops in our own minds and in the minds of others as we interact in community with others (and others (Boaler and Greeno 2000; Bohl and van Zoest 2002; Holland and Lachicotte 1998; Wenger 1998)).

The classroom is where a teacher works within the setting she creates for herself and her children, where her experiences underpin and reinforce, modify and extend who she is in her world. Research shows that teachers are not waiting to be filled with theoretical and pedagogical knowledge and skills; they enter the profession with myriad prior experiences, personal values and beliefs that inform and shape their knowledge about and understanding of classrooms and all that happens in them (McDiarmid 1990; Stuart and Thurlow 2000). Through all this they develop their professional identities (Van Zoest and Bohl 2005).

#### **2.2.4 Summary of section: Cognitive theme**

The literature review in this first section has shown that a teacher’s identity, informed by knowledge and beliefs about the nature of teaching, learning and mathematics, is a

significant influence on his or her practice. The distinction between beliefs and knowledge is fuzzy (Pehkonen & Pietilä 2003), although Abelson (1979) and Nespor (1987) suggest that beliefs are consensual and consequently, disputable, while knowledge is generally verifiable. Thus beliefs ‘are distinguishable from knowledge only in terms of the degree of consensus they attract’ (Beswick, 2005, p39). For the purposes of this study I take beliefs to be ‘subjective, experienced-based, often implicit knowledge’ (Pehkonen & Pietilä, 2003, p2). This definition of beliefs relates to notions of identity found in the work of McDiarmid (1990), Stuart and Thurlow (2000) and van Zoest & Bohl’s (2005). They argue that a teacher’s identity is based on prior experience, personal values and beliefs that have informed and shaped their knowledge and understanding about how to teach children and shape what they do in the classroom.

## 2.3 Theme two: Pedagogical (Whole Class Teaching)

- Interaction in the mathematics classroom
- Classroom discourse
- Critical moments
- Teacher actions and styles

Each of these topics has been selected to review the literature in order to construct clear research questions that relate directly to these elements. I will now discuss the literature each in turn and summarise in a table on pages 26 and 27.

### 2.3.1 Interaction in the mathematics classroom

Over the last few years the term ‘interactive teaching’ has become an integral part of an English primary teacher’s vocabulary. Recent, government initiatives, focused on both literacy and numeracy, have promoted an emphasis on a ‘whole class’ approach to teaching (DfEE 1998; 1999). This emphasis derived partly from Reynolds and Farrell’s (1996) analyses of the international literature comparing English classrooms with those elsewhere and partly on the findings of projects like those undertaken in the London Borough of Barking and Dagenham, which worked on a collaborative pedagogy designed to reduce gaps between more and less able pupils’ achievements (Alexander 2000; Luxton 2000).

The expression ‘interactive teaching’ is not new, being introduced in the USA in the late 1920s (Delamont, 1983), when the rise of fascism in Europe led to teachers being assessed according to ‘the limits they place on pupils’ freedom of speech’ (Delamont, 1983, p17 in English et al. 2002, p10). The principle can be traced back to the ancient Greeks, as

recognised in the expression Socratic teaching, who were apparently masters of the technique (Orlich et al. 1998). However, 'interactive teaching' is one of many interactive techniques which more recent researchers have investigated and categorised (Flanders, 1970). One aspect of this, identified in the UK, concerned the well-known 'initiation-response-feedback' (IRF) model of teacher questioning (Sinclair and Coulthard 1975). Other studies, also undertaken in the UK, have found, in similar vein to Flanders (1970), that of a primary lesson's time 45% involved teachers making statements and 12% asking questions (Galton et al. 1980). After the introduction of the National Curriculum, in 1989, these proportions increased to 67% and 18% respectively, although opportunities for pupil contributions remained largely unchanged (Galton et al (1999) p69).

Later work (e.g. Alexander, 1995, 2000) continues to echo the past. Alexander analysed mathematics classroom teacher-pupil interaction and found little evidence of Bruner's (1986) encouragement of a negotiated shared meaning. He found, instead, missed opportunities to extend and make meaningful teachers' interactions with their pupils. English et al. (2002), focused on the changes in teacher behaviour since the NLS was implemented in 1998. Their data revealed that key stage 1 teachers tended to use higher levels of low cognitive interactions with fewer children being asked questions and fewer sustained interactions observed since the introduction of the strategy. This was substantiated by Moyles et al. (2003) and later (Pratt, 2006), who argue strongly that effective interactive teaching is characterised by *sustained* interchanges between teacher and learners, where a sharing of ideas rather than the IRF sequence, is encouraged. Significantly, materials provided by the NLS (1998) and the NNS (DfEE 1999) to support teachers' promotion of speaking and listening, seem to have had less impact than expected. Haworth (2001), and more recently (Pratt, 2006) for example, found that 'speaking' was 'suppressed' and 'listening' was the main role of a student. Both studies portrayed the teacher as the 'controller of the spoken word', whilst the 'learners remain in the shadows' (Haworth, 2001,p14). That is, teachers continue to use the same organisational strategies as teachers before them.

Another aspect which the NLS and particularly the NNS have highlighted and recommended as an 'effective' teaching strategy for interactive whole-class teaching is the use of time. However, research has shown that many teachers interpret the word pace, in this respect, as referring to a rapid interchange of questions and answers(Alexander 2000; Mercer 1995; English et al. 2002). Such findings are unsurprising given the interpretation of pace found in

QCA summary reports and OfSTED documentation where one will find ‘quick pace’ as an indicator of ‘good teaching’. For example the QCA report on the implementation of the first year of the NNS (DfES,2000) commented that:

*Experiences of mental calculation should include quick recall of simple number facts. Children should be supported in using these facts to derive other related facts for use in harder mental calculations.* (QCA, 2000, p39).

Ofsted, reporting on a particular school, indicated that ‘rapid pace’ is the key to ‘good teaching and concluded that

*the pace at which they (pupils) develop their skills and understanding is rapid. Occasionally, lessons are a little slow or do not focus sharply enough on what is to be learnt and as a result pupils' learning is not as good as it could be* (Ofsted 2004).

Other examples include ‘...when the pace of lessons is too slow, learning is less effective’ (Ofsted, 2003) or ‘the pace of lessons is brisk and expectations are high’ (East Sussex Local Authority, 17Nov2004).

In short, when one sees such authoritative invocations, it is of little surprise that ‘an observer may be deceived into concluding that pace of classroom talk equates with pace of pupil learning’ (Alexander 2000, p430). This is at odds with the research discussed above where a rapid pace of interaction does not *per se* facilitate cognitive advancement (Mercer, 1995; English et al.,2002).

In this project it is important to acknowledge that if those in authority espouse such diverse interpretations of pace then it is probably inevitable that teachers will do so also. Thus, in framing my work I draw on Steinbring’s (2005) call for research to attend more explicitly to the processes of mathematical interaction, or the triplet of mathematics, student and teacher interrelationships, where one element cannot be ultimately reduced to the individual components. Importantly, if a key element of effective instruction lies in the interchange between a teacher and her children then classroom discourse and ‘critical moments’ should be analysed.

### **2.3.2 Classroom discourse**

If we accept that discourse is the process through which groups of individuals communicate (Cazden, 1986; Pimm, 1996) then, according to Sherin (2002), analyses of discourse ‘decompose these processes and underlying structures in different ways’(p206). For example, some analyses have attempted to catalogue ‘norms’ that define aspects of classroom discourse, for example who can speak and when (Sinclair, 1975). Others have

sought to identify discursive strategies used to support teaching and learning (Dawes, 2010), while others have examined the meaning of particular words and phrases in the context of what is being taught, from both empirical (Lampert 1986) and theoretical (Pimm 1987) perspectives.

In recent years, researchers, predominantly from the USA, have attempted to show how different forms of classroom discourse support a deeper student learning. In particular Cazden (2001) has shown, by means of her sociocultural analyses, how patterns of classroom talk affect the quality of students' learning opportunities and outcomes. She concludes that the right 'prompts' facilitate students' engagement in lively, focused and productive debate, from which solutions to problems will emerge. Cazden shows how classroom discourse affects the unobservable thinking of individual students and this will form a key element of my study.

In today's classroom, particularly the English mathematics classroom, pupils are expected to offer and explain their ideas and respond to the ideas of their peers. Teachers are expected to facilitate these conversations and elicit, guide and develop their pupils' thinking. Sherin (2002) would refer to this as a 'discourse community' and in the case of mathematics, a 'mathematical discourse community'. Ball (1993) and Lampert (1990) have researched the role of 'classroom talk' or a 'mathematical discourse community' through vignettes from their own classrooms. These have presented the mathematics educational community with examples of how ordinary classroom teachers can support this approach. However, as Pratt (2006) highlights, little support for the 'ordinary' teacher is available from the national strategies training materials (DfEE, 1999) in how to develop this approach in their teaching. Primary teachers agree that part of their role is to facilitate these conversations, yet he and others (Smith et al, 2004) record how only a 'veneer' of collaborative talk can be seen in the classroom still. A static traditional approach still resonates in primary classrooms where children still see their role as listener, not partner in classroom talk.

Analyses of classroom discourse offer powerful lenses through which to view the whole class interactive episodes of a teacher's lessons. However, as I have tried to show above, teachers' beliefs, identity and attitudes also affect what they do in any given situation. Moreover, one cannot leave the review of 'classroom talk' to the field of classroom discourse alone as there is much to be drawn from the literature specific to 'mathematics talk'. Durkin and Shire (1991) and Pimm (1987), for example, discuss the importance of technical mathematical

language and its role in the learning of mathematics. Furthermore the use of language to ‘scaffold’ abstract ideas should also be acknowledged as it has no obvious relationship to the physical world from which students derive much of their mathematical understanding. In sum, As ‘students’ active manipulation of new language forms, functions and concepts through talking as well as writing are crucial tools in the acquisition process’ (Gibbons 2003 p2).

### 2.3.3 Critical incidents

Critical moments are known to play a significant role in teachers’ decision-making, particularly in respect of lesson transitions (Cooney 1987). For example a child may ask a question which is unrelated to the teacher’s intention or plan, resulting in the teacher having to decide whether to a) answer it directly, b) dismiss it, c) say they will discuss it another time or d) accept the question and relate to the planned focus/intention. Such decisions, made in the moment, are typically construed as critical incidents. They draw on ‘the personal nature and context-relatedness of knowledge, and its corresponding unpredictability of application in classroom situations’ (Jaworski 2003, p255). It would be impossible for teachers to predict what would happen during classroom discussion, although their knowledge and experience will inform how they exploit these ‘moments’ and, when examined systematically, help build a ‘picture’ of an individual teacher (Eraut 1993; Wilson et al. 1987). Indeed it would be interesting to observe in this study, when such moments occur in a classroom, whether teachers act in predictable ways.

If language and classroom talk are considered to be at the heart of learning then clearly the ways in which teachers manage language or discourse-related critical incidents would be major determinants of learning. It is generally accepted that the complex interplay of thought and language shapes meaning (Vygotsky, 1978). Indeed, language ‘structures and directs the processes of thinking and concept formation’ (Wood 1988 p29). Therefore the notion that language has a significant influence on the structure of thought is not unreasonable, and that cognitive development is a social and communicative process in which the role of the teacher is crucial (Vygotsky, 1978). A key element of this can lie with the Zone of Proximal Development (ZPD), which Vygotsky construed as a way of defining the potential learning of the individual with the support of an informed other, not necessarily the teacher. One could argue that ‘the theory was a reaction to positivist views of a measurable and fixed intelligence quotient which could quantify children’s cognitive potential through the application of a test and the calibration of the result against a

standardised score' (Myhill & Warren 2005 p57). Furthermore, Vygotsky was principally concerned with assessment of potential, where the difference between actual and potential achievement is the ZPD and can therefore vary from person to person (Mercer 2000).

From my own experience of working with primary teachers and PNS Numeracy Consultants, it suggests that they find the term useful in their understanding about how they might facilitate learning. Particularly in the current PNS climate of 'individualised learning' and 'target setting', where teachers are required to identify targets, just beyond an individual's comfort zone, that they can easily achieve (Myhill & Warren, 2000). These sentiments echo those of Vygotsky (1986, p188), whereby 'the only good kind of instruction is that which marches ahead of development and leads it: it must be aimed not so much at the ripe as at the ripening functions'. Although, if we really analyse what ZPD really means it is not just about knowledge; it is about becoming able, through language, to operate on a 'higher plane'.

The ideas gathered above will certainly inform this study in identifying what teachers have interpreted from PNS guidance and how it impacts on their thinking, understanding and classroom enactment. If I refer back to the National Numeracy Strategy (1999) and the Primary National Strategy (PNS 2003), I will find ZPD translated into classroom practice through the idea of 'scaffolding'. Maybin et al. (1992) define scaffolding as the 'temporary, but essential, nature of the mentor's assistance as the learner advances in knowledge and understanding' (P186). This suggests that the process of scaffolding is the device by which a teacher might shift her students' current understanding to a new, perhaps deeper understanding.

I will now consider in the next section, how teachers' scaffolding and other strategies might present themselves in the classroom, drawing from the guidance teachers are given from the PNS and related research literature.

#### **2.3.4 Teacher actions and styles**

The PNS and NNS, as well as the National Literacy Strategy (NLS), refer to 'scaffolding' as an 'effective teaching style' implying, perhaps, a 'watered-down' version of what Vygotsky intended. For example if we look at some of the literature:

*Remind colleagues that the whole-school targets are broken down into age-related targets for each half-term for each class and then scaffolded or differentiated to ensure that all children have an expectation set for the half-term. Note: Children in the target group should be set the age-related expectations (DfES, 2005 p28 p6).*

This document (DfES, 2005 p28) offers professional development to head teachers and class teachers in setting curriculum targets for ‘teaching and learning’ but offers no clue to what ‘scaffolding’ really means.

OfSTED also refers to scaffolding in their PNS evaluation document 2004/5, suggesting that assessment for learning was seen as effective in primary schools when teachers:

*demonstrate an effective balance between observing, intervening with additional support and scaffolding questions, from the literal to the more demanding, to meet the needs of all pupils (OfSTED, 2005 p29, p16).*

In such writing are implications that the meaning of ‘scaffolding’ is known and understood by the readers. However as these two documents suggest different meanings are assumed. Myhill & Warren (2005) suggest that ‘like all words which suddenly gain a common currency in any sphere, the term ‘scaffolding’ is in danger of becoming a vague word for every activity engaged upon in the classroom’ (p57). They also suggest that this may be because most classroom activities are intended to support learning. Indeed, when examining the national strategy’s literature, one finds that this broad use of ‘scaffolding’ embodied within teaching styles and strategies. For example instructions for using the PNS Wave 3 materials, with respect to teaching styles (another contested expression) focus on

*addressing the needs of visual, aural and kinaesthetic learners in the presentation of the teaching activities. Additional scaffolding opportunities are presented in the shaded boxes within the text (DfES 2006, p16).*

The NLS (DfEE 2001) and PNS in mathematics and literacy frameworks (DfES 2006) all refer to ‘scaffolding’ as an ‘effective teaching style’. I would argue that scaffolding is a teaching strategy rather than a teaching style as the latter implies something larger and broader than a single characteristic behaviour, which a strategy may embody. Other strategies defined by the PNS are demonstrations and modelling by the teacher to show their pupils how to calculate a particular question using a particular method for example. Also questioning is offered as a means ‘to probe, draw out or extend children’s thinking’ (DfEE, 2001, p16). As Myhill & Warren (2005) argue, all these things are scaffolding mechanisms. Importantly, scaffolding is a temporary method to support learners while they acquire appropriate knowledge, skills and understanding in order to move towards working independently (Maybin et al 1992).

This sense of transience is an important consideration in respect of the teacher’s role. In fact research studies that have reported on the process of learners becoming independent; such

as Mercer (1995), argue that this handover to independence rarely occurs and that ‘instead of acting as a temporary supporting scaffold, many teaching strategies or teacher-pupil interactions act as a heavy prompt or even a straitjacket upon pupil learning’ (Myhill & Warren 2005, p58). For example, Myhill & Warren show how the frequent use of writing frames and teacher questions give ‘strong clues to the ‘right’ answer to examples of how easy it is to slide from scaffolding as a learning mechanism to scaffolding as a device to enable pupils to complete a task successfully, without necessarily grasping the learning at the heart of the task’ (p58). This view might also be applied to mathematics teaching, as procedures and preferred methods are offered pupils to calculate and solve problems, not as a learning mechanism, but a device to enable the pupils to get the ‘right’ answer.

When trying to summarise these last three sections, and acknowledging their complexities, I see a possible overlap in the ways in which classroom discourse, critical moments and teacher actions and strategies contain interact. However, an element they fail to acknowledge but one increasingly viewed as important in mathematics education research lies in the emergent field of ‘gestures’.

#### **2.3.4.1      Gesture**

Arzarello et al. (2006, 2008), working from the perspective of cognitive psychology, suggest that ‘gestures’ have a ‘cognitive dimension that involves such abilities as movement’s coordination, languages, attention, thought etc. They can support the relationship between theory and practice when learning mathematics’ (p255). He discusses how the gestures people exploit when solving a mathematical problem may be a ‘thinking tool’. This is an interesting proposition as there is a received view that many teachers use their hands and bodies to express themselves when explaining or describing something new to children. There is relatively little mathematics education research in this area and it would certainly be an interesting for this study to explore a teacher’s understanding of what their gestures might mean within any observed situation. Arzarello et al. (2006) go as far as to say that the role of gestures is especially clear in the development of formal language, as they support the student in the creation of new ideas and in the production of mathematical signs. Indeed, Vygotsky (1997) pointed to the ‘double nature’ of gesture (both a psychological and a social character) in that a ‘gesture is specifically the initial visual sign in which the future writing of the child is contained as the future oak is contained in the seed. The gesture is a writing in the air and the written sign is very frequently simply a fixed gesture’ (in Arzarello et al. 2006, p257). This may constitute a ‘fresh approach’ to symbolising activities; crucial in

mathematics, and I would agree that these activities could be seen as deeply based on our sensory-motor system. That is, ‘thinking with hands is not only a metaphor but a phenomenon which happens really in the classroom’ (p257). They write that gestures are an important example of Vygotsky’s cultural signs; they take the idea that gestures are *strong* cognitive tools that mediate the internalisation processes of the mathematical knowledge.

From a different perspective, Miller & Glover (2006) have examined the use of gesture as a mediation between the teacher and an interactive whiteboard. Early indicators are that children find their teachers are more lively (gesturing) when teaching through this medium and that they are more ready to ‘seek alternative ways of offering explanation and example and more responsive to learner need. Gesture may be a product or a prompt in achieving this’ (p7). Certainly nearly all English primary classrooms boast the presence of an interactive whiteboard, so it is conjectured that gesture will be an important consideration with respect to understanding the beliefs and actions of project teachers.

McNeill (2000) categorised spontaneous and speech-related gestures into five groupings:

- Iconics (close formal relationship to the *semantic content* of speech) e.g. teacher takes on a caricature of a student struggling with some mathematical apparatus
- Metaphorics (the pictorial content presents an *abstract idea* rather than a concrete object or event) e.g. teacher offers themselves as a balance scale with arms stretched out to their sides to help describe equality in a linear equation
- Beats (the hand moves along with rhythmical pulsation of speech) teacher moves hand along a numberline as they count up the scale represented
- Cohesives (serve to tie together *thematically related but temporally separated parts* of the discourse) e.g. teacher repeats the same gesture form or movement in the same space: the repetition is what signals the continuity (finding coordinates on a graph)
- Deictics (pointing gestures) e.g. teacher pointing to a shape or area

These groupings offer a descriptive interpretation of what might be observed in project classroom. The most interesting aspect might be the way in which the participant teacher describes her gestures and more importantly, her reasons for and understanding of why she uses any gesture at any given point.

## 2.4 Summary

The literature has clearly highlighted some very important areas to frame the direction of this study. As the introduction to this chapter implied, there are two themes which clearly inform my research questions. The first relates to the influences that affect a teacher’s

organisation and presentation of mathematics during a mathematics lesson. The second relates to the opportunities that teachers present their classes during whole class interactive episodes, which are framed by discourse, gestures and actions.

Based on the issues raised above, I have created a framework (Figure 2.1) to help me ‘see’ how the different issues interact. Presented as a tetrahedron, the four vertices represent, as the literature has shown in this chapter, the influences on the teacher’s understanding or conceptualisation of their whole class interactive teaching phases.

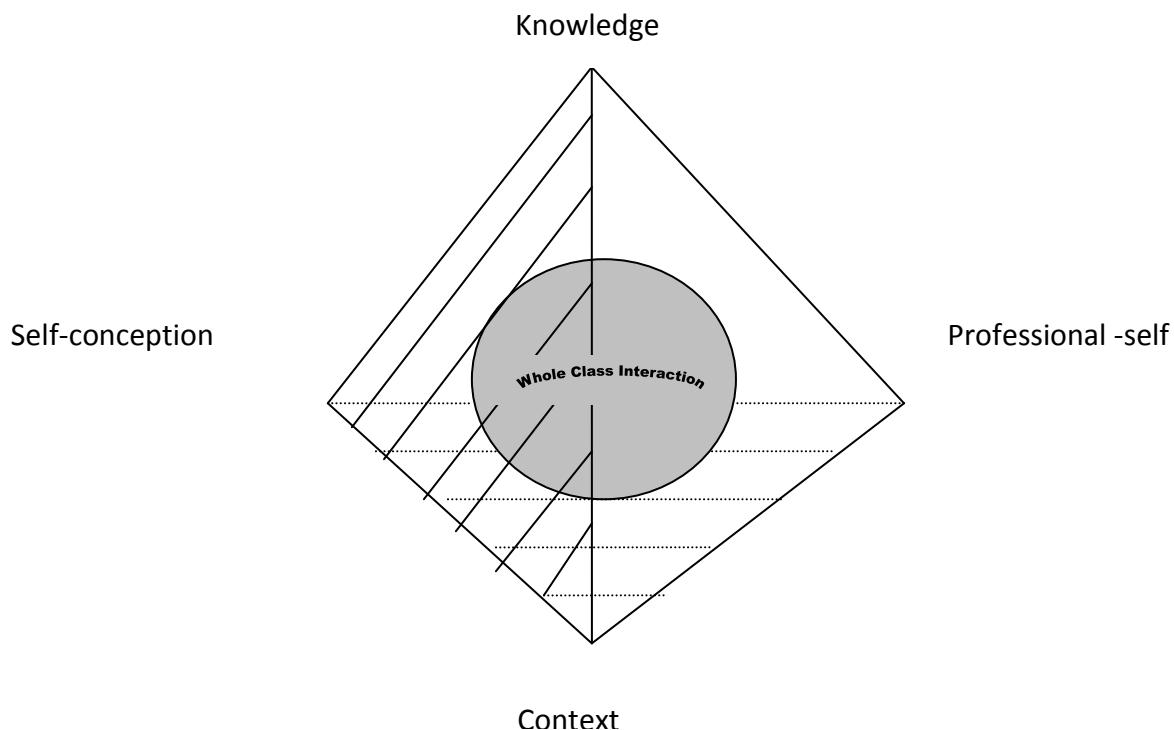


Figure 2.1: Preliminary model of Theoretical Framework of the influences on a teacher’s participation in whole class interaction.

In closing this chapter, I return to my research questions. It is my intention to examine teachers’ knowledge, beliefs and identity as the literature has clearly highlighted the importance of the interrelationship between these areas on teachers’ conceptions about their whole class interactive teaching (WCIT) practice. The following question has been identified:

*How do primary teachers of mathematics conceptualise the whole class aspect of their work?*

The sub-questions:

1. *What knowledge and beliefs underpin their actions?*
2. *In what ways do the espoused beliefs resonate with the enacted?*

### 3. What justifications do they present for their actions?

The order of these questions is perhaps not relevant for the purpose of this chapter. However, the literature implies a sequential order in that a teacher's beliefs and attitudes and knowledge underpin what they do. There is certainly an overlap between the questions in relation to the two themes identified at the beginning of this chapter. For example the main question draws on cognitive aspects of a teacher: Their knowledge, identify and their beliefs and attitudes towards mathematics and its teaching. Each sub-question is also listed in the table (2.1) below to illustrate the overlap of both cognitive and pedagogical approaches teachers make (each section of literature review are shown in bold relevant to each question).

| Question | Related Theme            | Rationale   |
|----------|--------------------------|---|
| Main     | Cognitive<br>Pedagogical | <p>The main question will draw on a teacher's <b>subject knowledge, core beliefs</b> about learning, and learning mathematics and how they view their role as teacher of mathematics (their <b>identity</b>). These will inform the following pedagogical approaches:</p> <p>What the teacher thinks about <b>whole class interactive</b> mathematics teaching (how the teacher structures, organises phase, ability grouping, sitting at tables/floor etc. The <b>communication</b> and <b>discourse</b> afforded or constrained, in general across <b>WCI</b> phases, and in particular at <b>critical moments</b>.</p> <p>What <b>actions</b> the teacher is seen to take, e.g. use of manipulatives to demonstrate new concepts, use an interactive whiteboard if so how and why.</p> |
| Sub 1    | Cognitive<br>Pedagogical | <p>Questions will be asked of the teacher about their early experiences of learning mathematics, what they enjoyed about the subject and what they enjoy about teaching the subject (<b>attitudes and beliefs</b>). Any <b>influences</b> they believe affected their perspective of <b>subject knowledge</b> and <b>approaches to teaching</b> will also be identified.</p> <p>Questions will be asked about their <b>training</b> as a teacher, as a mathematics specialist, and the type of CPD they have engaged in during their career.</p> <p>They will be asked what they <b>believe</b> good teaching of mathematics looks like and what a typical mathematics lesson might look like (perception of <b>WCIT, Discourse, actions</b> etc.) in their classroom.</p>                |
| Sub 2    | Cognitive<br>Pedagogical | <p>The rationale teachers' offer will be viewed against <b>their subject knowledge, beliefs and attitudes</b> and their <b>identity</b> presented.</p> <p>Drawing on lesson observations teachers will provide rationales of their knowledge and understanding of <b>WCIT, classroom discourse, actions and gestures</b> in relation to mathematical thinking and development.</p> <p>These views and rationales will be analysed against their initial interviews to identify whether espoused beliefs match the enacted</p>   |

|       |                         |  |
|-------|-------------------------|--|
|       |                         | practice. Does this point of view resonate with their <b>identity</b> as a teacher/mathematician/learner?  |
| Sub 3 | Cognitive & Pedagogical | <p>This question will address particular instances that are identified in <b>WCIT</b> phases by both researcher and teacher.</p> <p><b>Subject knowledge, pedagogical content knowledge</b> and the way in which mathematics is presented to children will be analysed against what the teachers provide as justifications for their actions in <b>WCIT</b> phases, e.g. use of <b>communication and classroom discourse</b>, their <b>actions and gestures</b>.</p> |

Table 2.1: Research Questions Rationale

The table illustrates the overlap of the key themes that have emerged from the literature review: Cognitive and Pedagogical. Many overlaps within each sub-question relating to the particular strand to each theme, can be seen in the table.

Further explication of these questions will be addressed in detail in the following chapter when I present the methods employed to investigate them. The following chapter will illustrate the design of the research through presenting the methodological approach and the methods to be employed in this study.

## Chapter 3 Research methodology and Design

### 3.1 Overview

The previous chapter drew attention to the little that is known about what a ‘generalist’ primary teacher understands about whole class interaction (WCIT) in a mathematics lesson. It also indicated a strong link between teachers’ belief systems and their practice. In addition, research indicates that teachers create a classroom ‘culture’ or what might be considered a ‘norm’ for whole class interaction in the primary mathematics lesson. Consequently, conducting a study in this relatively under-researched area should contribute professionally useful results.

The research questions presented at the end of the previous chapter arose from my interests, experiences and background, and, of course, my interpretation of the literature. I recognise that these choices are personal and will impact on the methods I employ to collect and analyse my data, and other researchers may have identified different questions and methods to research the same area. The scale of this study is necessarily limited, although, as shown below, I collected a comprehensive and rich data set that will (with appropriate permission) be available for secondary analysis.

### 3.2 Research Questions

In chapter one I discussed how my experiences as a teaching assistant, a primary teacher and then a teacher trainer led me to ask what do teachers do, and what is their justification for what they do, in the whole class teaching phases of their mathematics lesson? The literature provided a comprehensive set of perspectives with respect to *what* can be observed in WCI phases, however I argued that little is offered from a primary teacher’s perspective, despite the unprecedented emphasis on ‘direct teaching’ (NNS, DfEE, 1999) in English primary schools. In chapter two I reported that the literature suggested two key influences affecting mathematics teachers’ practice: their espoused beliefs with respect to the nature of mathematics and its teaching; and the depth of a teacher’s deep subject knowledge. Consequently, the study, and its design, was driven by a single over-arching question and three sub-questions. The overarching question was:

**How do primary teachers of mathematics conceptualise the whole class aspect of their work?**

As will be shown below, the design will incorporate the traditions of a multiple case study. Therefore, due to the limited resources available, and the desire to maximise the quality of data yielded by each case, a maximum of six teachers was decided to be manageable.

The research sub-questions are:

**1) What beliefs underpin teachers' actions?**

School-level research has highlighted teachers' mathematics teaching-related beliefs as having a considerable influence on their classroom actions and decision-making. Consequently, investigating collaboratively with teachers the construction of their belief systems would seem to be important. However, unless one attempts to understand how these beliefs impact on practice, research will tell only a partial story. Consequently the next question addresses this issue.

**2) In what ways do espoused beliefs resonate with enacted?**

This second question relates directly to what can be observed in the classroom. As highlighted in the previous chapter, school-based studies have shown that teachers' beliefs may or may not resonate with enacted practice. As above, this question calls for a rich qualitative approach to describing and synthesising what is observed in the classroom. Also, understanding how beliefs inform practice requires an understanding of how teachers justify their pedagogical decision-making. This alludes to my final sub-question

**3) What justifications do they present for their actions?**

The formulation of this question assumes that all teachers understand why they perform particular 'actions' (Dweck, 2000). However, as indicated in the previous chapter, we have little knowledge of the characteristics of primary teachers' conceptions of mathematics-related WCIT. Therefore it is thought to be important to explore how teachers' warrant their actions, as this will offer further insight into the interaction of espoused and enacted beliefs.

### **3.3 Research Design**

Crotty (1998) presents a useful diagram (Figure 3.1) to illustrate the relationship between different elements that form an approach to the research process.

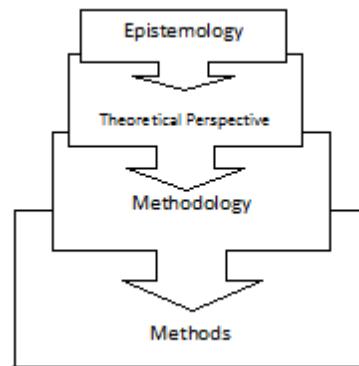


Figure 3.1: Basic elements of the research process (Crotty, 1998, p4)

Crotty's model is based on Kuhn's (1962) notion of paradigm, which, along with much current literature (Denzin and Lincoln, 2000; Guba, 1990; Punch, 2005; Shulman, 1986; and Silverman, 2010) refers to research communities and the approaches, or world views, they share. Indeed there are many competing and incommensurable approaches to educational research, although Walker and Evans (1997) and Punch (2005) suggest that the suitability of any paradigm should be assessed by examining its appropriateness for addressing the research questions. Therefore, adopting this perspective, the following sections will present a case, highlighted in figure 3.2, for a constructionist epistemology and symbolic interactionist theoretical perspective. Methodologically I argue for a multiple case study that exploits a range of appropriate data collection methods.

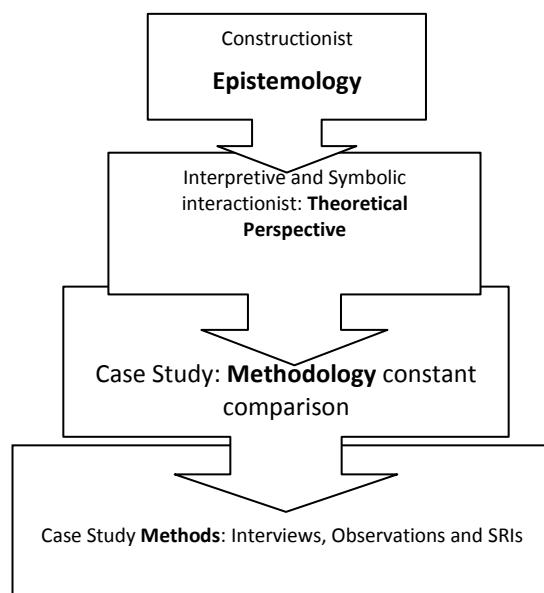


Figure 3.2: Adapted research framework drawn from Crotty (1998)

### **3.3.1 A Constructionist Epistemology**

According to Crotty (1998), there are three broad epistemological positions: objectivism, subjectivism and constructionism. Objectivism espouses the belief that an absolute knowledge of the world exists and that reality exists separately from an individual's experience of it. Cohen et al. (2000) describe this as, an object in the world that has meaning outside any perception of it, based on a logic of discovery. In a study of this nature, where I am aiming to understand how individuals construe their professional context, the notion of an absolute and immutable knowledge seems inappropriate. Subjectivism, which rejects the notion that reality is 'out there', finds its origins in a logic of interpretation dependent upon what individuals bring to the moment of perception (Cohen et al., 2000; Denzin & Lincoln, 2000). However, an epistemology reliant on the interpretation of the researcher independent of the interpretation of the researched also seems inappropriate for my study. Finally, in contrast to objectivism, constructionism also rejects the notion that reality is out there. However, in a departure from subjectivism, it adopts the stance that knowledge of the social world is not only a construction, drawing on the experiences of participants in that social world, but also a co-construction in the sense that meaning is negotiated by and between those participants. From a constructionist perspective, knowledge is more than the subjective interpretations of an individual in its necessitating negotiation. Consequently, for a study such as this, it seemed the most appropriate starting point.

### **3.3.2 Naturalistic Theoretical Perspective: Symbolic Interactionism**

When I examined the research questions it seemed clear to me that my interests lie in the uniqueness of a teacher's perspective. I wanted to understand individuals and not the collective. I wanted to be able to explain why people behave in certain ways under certain circumstances as Hoyles (1992) has discussed previously. This demands, I believe, an approach to data collection and analysis which foregrounds the individual and leads me to an 'interpretive' or 'naturalistic' study (Guba and Lincoln, 1994, 1985). Naturalistic approaches, as implied by a constructionist epistemology, facilitate the investigation of behaviour in its natural social setting. They acknowledge that internalised notions of norms, traditions, roles and values are crucial contextual variables. According to Merriam (1988) and Creswell (1994) qualitative researchers are interested in *meaning* and how people make sense of their lives, experiences, and their structures of the world. Such traditions seek not to reduce data by coding and standardising but celebrate the unique voice of the individual.

Consequently, I believed that my research questions demanded a theoretical perspective commensurate with these aims.

Inspired by Blumer (1969) and the theory of *symbolic interactionism*, Bauersfeld (1988) wrote that in order to understand classroom interaction, one has to perceive it as such. In other words, as ‘one has to focus not on the alternation actions of teachers and students as cause and effect respectively, but on the evolving patterns and the intersubjective constitution for norms for action’(Skott, 2008. p5); suggesting that meaning about the world draws on the everyday rituals and routines we experience in the contexts in which we operate. Blumer (1969) contended that ‘societies’ or ‘cultures’ exist only in *action*, and therefore must be viewed in *action* thus social interaction must be observed to be understood. This perspective, described as *symbolic interactionism*, matched well with my desire to observe whole class interaction in order to reveal how teachers make meaning through the everyday social interaction patterns, or ‘culture’, they create in their classrooms. The outcomes of this approach indicated how data would be gathered and why, so I will now present the methodological and methods I used in the study here.

### 3.3.3 Case study methodology

According to Robson (2002, p178) there are three traditional qualitative research methodologies: grounded theory; ethnography and case study. As indicated above, I have elected to work within the traditions of symbolic interactionism and will now explain why a case study methodology is appropriate for my study within that broader theoretical frame.

While a number of studies have addressed teachers’ mathematics teaching-related beliefs by means of surveys and statistical analyses (Andrews and Hatch, 2000; Mura, 1993, 1995), typical methodologies have exploited qualitative approaches to both data collection and analysis (Beswick, 2005; Jaworski, 1994; Myhill & Warren, 2005; Steward & Nardi, 2003; Swan, 2006). However, the former lack depth and assume that teachers’ beliefs are well covered by pre-determined categorisations. Moreover, the extent to which such categorisations afford insight into teachers’ practices is not well known as few studies have linked such measures to analyses of classroom practice. A case study, on the other hand, allows an appropriate deep enquiry into individual’s perceptions of and justifications for, whole class interactive (WCI) phases of mathematics lessons. Unlike traditional survey approaches, I was interested in individuals and what they think. I was not looking to generalise. I was interested in process, meaning, and understanding gained through words

and pictures captured on video-taped lessons. I observed the interactions between the teacher and her class and by video-taping the lessons, enabled me to analyse the observation further than the lesson.

Case study is a research tradition focused on the examination of a case (or multiple cases) through an analysis of detailed and in-depth data yielded by a multiplicity of data collection approaches, typically qualitative, that are sensitive to context. In so doing case study seeks to understand and interpret the social world from the participants' perspective (Bassey 1999; Creswell 1998; Robson 2002; Sturman 1997). Case studies have been variously categorised. For example, Yin (2009) writes of exploratory, descriptive and explanatory case studies. The first aims to generate hypotheses about the social phenomenon under scrutiny; the second a narrative account, while the third focuses on the testing of theories. Stake (2002) also highlights three forms of case study; intrinsic, instrumental and multiple. In the first the case itself is of intrinsic interest. In the second interest in the case is subordinated to an understanding of something else, possibly the testing or refining of theory. Finally, a number of cases are examined to offer insight into a particular phenomenon or population. Set against these descriptions, I construed my study as a multiple exploratory study. It is multiple in the sense that I worked with several teachers in the process of addressing my research questions. The focus of interest is belief formation and the relationship between espoused and enacted beliefs and so a collective case study seemed appropriate. It is exploratory because I aimed to generate theory highlighting the nature of these relationships.

Case study has been criticised for its inability to generate generalities. In respect of this study, I do not perceive this as an issue as generalisability was not the aim of my study. That said, it is important to note that within the case study tradition is an understanding that cases themselves afford an internal generalisability (Maxwell 1992; 1996 in Robson 2002). In the context of this study it would be reasonable to expect that a given teacher would behave in consistent and predictable ways from one lesson to another and exhibit, therefore, an internally generalisable set of behavioural characteristics and clearly I needed to be mindful of such matters as I undertake both data collection and analysis. Such perspectives on generalisability differ from the traditional, positivist, perspective on external generalisability whereby research aims to go beyond the individual cases and make statements about primary mathematics teachers in general. My aim, as indicated above, was an exploratory case study from which theories for future testing may emerge. This is different from any

attempt to generalise to a wider population. In other words, the primary concern for this study was the optimal understanding of a multiple of individual cases rather than generalisations that may or may not be made beyond it (Stake, 2002).

As is explained in some detail below, data collection for the case studies drew on preliminary, semi structured interviews designed to investigate teachers' professional life histories and their influence in the construction of colleagues' beliefs about mathematics and its teaching. These were followed by a series of, typically six, lesson observations, which included videotaping, and post lesson stimulated recall interviews in which colleagues were invited to discuss their professional decision making in relation to the video evidence. Such approaches yielded large amounts of data appropriate for qualitative analysis, and in the following I outline my perspectives on that process.

### **3.3.3.1 Constant comparison analysis**

In their introduction to grounded theory as research strategy Glaser & Strauss (1967) proposed an inductive approach to data analysis whereby theory was generated from the data and not predetermined categories. Arguably, this suited the purpose of my study in that I intended to generate theory inductively from the data I collected. Indeed, 'Generating a theory from data means that most hypotheses and concepts not only come from the data, but are systematically worked out in relation to the data during the course of the research' (1968, p6). If this is how the theory generation is described, then it is an emergent process and commensurate with the aims of this study. However, Lincoln and Guba (1985) have argued that enquiry is not and cannot be value free; therefore, any given inquiry will necessarily serve some value agenda. Consequently, in relation to the approach taken in this study, I should acknowledge that I come to the enquiry with a well-formed prior knowledge of the field; my mind is not untainted by experience (Strauss & Corbin, 1990). Mindful of such matters, the following shows how I construed the constant comparison approach to analysis espoused by grounded theorists, even though I am not undertaking a grounded theory study; my aim was not to collect data, undertake an initial theorisation before undertaking further data collection.

The constant comparison method has been described by Glaser and Corbin (1998) as comprising four distinct stages:

1. Comparing incidents applicable to each category
2. Integrating categories and their properties

3. Delimiting the theory and
4. Writing the theory

(Lincoln & Guba, 1985, p339)

The analysis of data in this study followed these four guidelines, where practice was observed and analysed combining ‘inductive category coding with simultaneous comparison of all social incidents observed’ (Goetz & LeCompte, 1981, p58). In practice, this entailed transcripts, interview and lesson, and lesson narratives being read, re-read, and categories of response being noted. A sample of these transcripts can be found in Appendices 3.3 and 3.4. As new categories were identified, previously read transcripts were re-read to see if the new categories found additional resonance (Andrews 2007b). The advantage of this method is that it did not restrict me to a specific theory to be tested or clarified (Strauss & Corbin, 1998) thus enabling me to construct a theory that applied exactly to the research phenomenon. In sum, constant comparison or inductive analysis is appropriate for this study in order to reveal meaningful patterns or themes.

### **3.4 Methods: Instrument Tools for data collection**

The research questions, warranting a symbolic interactionist theoretical perspective and case study methodology, implied a particular set of data collection tools appropriate for depth and breadth (Yin, 2009; Robson, 2002). These methods, or tools, are discussed in the following.

#### **3.4.1 Interviews**

Frequently described as a conversation with a purpose, research interviews take several forms (Robson 2002), and it is the role of the researcher to decide which form is most appropriate for addressing the interview purpose. For example, in educational research one frequently finds structured, semi-structured and unstructured formats. The first are tightly managed and allow few opportunities for informants to expand on a theme or idea. The second, clearly focused on a number of themes of interest to the researcher, allow for informants to talk at length and may prompt conversational episode. The third are not structured in any way and take the form of a genuine conversation in which authority for introducing an idea may rest with either participant. From the perspective of my study, I argue that the most appropriate form of interview is the semi-structured. Its predetermined,

usually open questions, allowed for modifications during the interview itself and enabled the interviewee to feel not only relaxed but valued as a participant.

Within the study, two distinct forms of semi-structured interviews were proposed. The first, preliminary, interview for each teacher facilitated the construction of a ‘narrative’ of the participant teacher’s experience and views about mathematics and the teaching of the subject (an example of transcript can be found in Appendix 3.3). A carefully worded set of questions, adapted from Sayers (2007), optimised interview time. These questions have been evaluated on colleagues, modified as appropriate (e.g. phrasing), and were initially trialled in the first phase of the study (see Appendix 3.2). The second form of semi-structured interviews took place after each lesson observation. I watched the video-recordings of the lessons with a view to identifying critical incidents in the teacher’s management of the WCI phases of the lesson. These incidents informed the development of a unique semi-structured interview schedule for a video stimulated recall interview (SRI) that was undertaken subsequent to each lesson (An example of a SRI interview transcript can be found in Appendix 3.4). In preparing the schedules, particular attention was paid to time (time the teacher was prepared to give and time available to me) and, perhaps more importantly, ameliorating the power relationship embedded in the interview process (Winter, 1991).

### **3.4.2 Observations**

Throughout the literature we find increasing support for observation as an appropriate technique for ‘getting at real life in the real world’ (Milne et al, 1999, p172). However, there are difficulties and disadvantages concerning the extent to which an observer affects the situation under observation. Another concern lies in the extent to which the researcher is confident that the observed behaviour is the ‘norm’ (Robson, 2002). These are important issues that will be addressed below. For example, sensitive positioning of the observer should minimise intrusion and multiple observations should minimise concerns with regard to typicality. Of course, an observer in the classroom, with no additional means of data collection, is limited with respect to what can be recorded both accurately and meaningfully. Consequently, an increasingly used tool in educational research is the video camera. An example of Lesson overview observation table can be found in Appendix 5.1.

### **3.4.2.1**

### **Video Observation**

There were several reasons a video-based study was chosen as the method for capturing observed mathematics lessons, which I will now discuss further. Petko et al. (2003) emphasise how new technologies create possibilities for teacher development, both in-service and preservice. One such possibility lies in how video based research can promote a deep understanding of classroom practice, particularly at a micro-level (Ulewicz & Beatty, 2001). In particular, research from the TIMSS (1999) video studies (Stigler et al., 2000) has highlighted both similarities and differences in mathematics classrooms around the world. The data set has led to intensive discussion on the quality of classroom teaching and consequently promoted further research. Other studies, such as the Mathematics Education Traditions of Europe (METE) project (Andrews et al., 2005), have shown not only how researchers from different European cultures can develop an observational schedule for reliable use in different project countries but also how mathematics teaching varies from one cultural context to another.

Importantly, a video record makes it possible to study complex processes such as the interactions in a busy classroom. As Stigler et al. (1999) report, video preserves classroom activity so it can be ‘slowed down and viewed multiple times making possible detailed descriptions of many classroom lessons’ (p3). A word of caution is also noted, as what appears to be an advantage can also allow this post-hoc analysis to be its problem. For as Ulewicz and Beatty (2001) note, video detaches events from their context and can distort perspective and limit the view of events. The advantages of video-taping include its ability to provide us with more contextual data than can audio recorded data (Gass & Houck, 1999). They provide the observer with a sense of who the teacher is and acquaint us with the setting in which she functions every day of the school week, as well as the types of activities she offers her class. Video makes it possible for us to examine posture, gestures and clothing. It allows us to see how teachers present themselves to their pupils. As already highlighted in the previous chapter, gestures, facial expressions and other visual cues also provide important information on the negotiation of meaning in environment the teacher creates. Finally the visual information in videos also provides information on directionality and intensity of attention, which as Dufon (2002) emphasises, can be useful in determining the levels of comfort and involvement of the pupils’ interactions with the teacher and each other.

Of course, a video-recording is limited in that it can capture only what it is allowed to capture; whatever one sees on tape has been framed by a host of decisions made before and as the data were collected (Hall, 2000). Moreover, during a lesson, decisions about where to locate the focus of attention are made instantaneously, judgements are not made explicit and moments cannot be recaptured if they are missed (Plowman and Stephen, 2008). Video is unable to capture neither the unspoken thoughts and feelings of a participant (Plowman & Stephen, 2008) nor the meaning behind behaviours (Erickson, 2011). Such matters may be guessed at or inferred, but one must be aware that this is the case. However, in the case of this study, playing a video back to a teacher as part of a Stimulate Recall Interview (SRI) may be seen as a great advantage (Corsaro, 1982; Erikson, 1975, and 1982) in its having the potential to facilitate their recalling their thoughts, feelings and reactions at different points throughout a lesson. Thus, despite its obvious strengths, one should be aware that in watching a video we tend to give ourselves uncritically to its authority (Tobin et al. 1989; Ulewicz and Beatty 2001).

### **3.4.2.2      Organisation of tools used**

The question of how and what equipment was to be used will now be presented in this section. The questions considered were as follows:

- How will the lesson interaction be taped?
- How will the data be stored?
- What sort of software will be needed?
- Will the researcher need training?

Each lesson will be taped, by me, on one tripod-mounted camera located at the back or side of the room. The precise location will be negotiated with the teacher participant to minimise disruption. Teachers will wear a radio microphone so that all their utterances can be recorded, although they will have the option to turn off the microphone should they feel it appropriate. A second, unobtrusive telescopic, microphone will be placed at the side of the room to capture student-talk in the whole class teaching phase.

The digital film will be downloaded onto a computer and, by means of Adobe™ Premier software, compressed into a format compatible with Inqscribe™ transcription software. A copy of the lesson file will be made for the teacher participant, transferred to CD, and sent to them. The transcription software will allow the creation of both text documents and subtitled video clips for analysis.

As a researcher on the METE project (2003-2005) I was introduced to these procedures and felt confident in applying them to my own study. Moreover, my initial thoughts with respect to analysis led me to conclude that the analytical framework developed by the METE team (Andrews 2007b) would be an appropriate tool for a first pass analysis of my observed lessons. This framework can be seen in table 3.2.

|                            |  |
|----------------------------|--|
| <b>Mathematical Focus:</b> | <b>The mathematical focus relates to the underlying objectives of a teacher's actions and decision making. There may be more than one such focus addressed within each episode of a lesson or, in fact, there may be no such focus for a particular episode.</b>               |
| Conceptual                 | The teacher claims to emphasise or encourage the conceptual development of his or her students.  |
| Structural                 | The teacher claims to emphasise or encourage the links or connections between different mathematical entities; concepts, properties etc.   |
| Procedural                 | The teacher claims to emphasise or encourage the acquisition of skills, procedures, techniques or algorithms.  |
| Efficiency                 | The teacher claims to emphasise or encourage learners' understanding or acquisition of processes or techniques that develop flexibility, elegance or critical comparison of working.   |
| Problem solving            | The teacher claims to emphasise or encourage learners' engagement with the solution of non-trivial or non-routine tasks.   |
| Reasoning                  | The teacher claims to emphasise or encourage learners' development and articulation of justification and argumentation.  |
| <b>Teacher Didactics</b>   | <b>METE: Different teachers use different didactic strategies in varying proportions and in different contexts. With the exception of sharing, which is an explicit public act, all strategies could be seen in both public (whole class) and private (seatwork) contexts.</b> |
| Activating prior knowledge | The teacher claims to focus learners' attention on mathematical content covered earlier in their careers in the form of a period of revision as preparation for activities to follow.  |
| Exercising prior knowledge | The teacher claims to focus learners' attention on mathematical content covered earlier in their careers in the form of a period of revision unrelated to any activities that follow.  |
| Explaining                 | The teacher claims that it is important to explain an idea or solution. This may include demonstration, explicit telling or the pedagogic modelling of higher level thinking. In such instances the teacher is the informer with little or no student input.                   |
| Sharing                    | The teacher claims that it is important to engage learners in a process of public sharing of ideas, solutions or answers. This may include whole-class discussions in which the teacher's role is one of manager   |

|                         |   |
|-------------------------|---|
|                         | rather than explicit informer.  |
| Exploring               | The teacher claims that it is important to engage learners in an activity, which is not teacher directed, from which a new mathematical idea is explicitly intended to emerge. Typically this activity could be an investigation or a sequence of structured problems, but in all cases learners are expected to articulate their findings. |
| Coaching                | The teacher claims that it is important to offer hints, prompts or feedback to facilitate their understanding of or abilities to undertake tasks or to correct errors or misunderstandings.   |
| Assessing or evaluating | The teacher claims to assesses or evaluates learners' responses to determine the overall attainment of the class.   |
| Motivating              | The teacher claims that it is important to, through actions beyond those of mere personality, explicitly addresses learners' attitudes, beliefs or emotional responses towards mathematics.   |
| Questioning             | The teacher claims that it is important to explicitly use a sequence of questions, perhaps Socratic, which lead pupils to build up new mathematical ideas or clarify or refine existing ones.   |
| Differentiation         | The teacher explicitly attempts to treat students differently in terms of the kind of tasks or activities, the kind of materials provided, and/or the kind of expected outcome in order to make instruction optimally adapted to the learners' characteristics and needs.   |

Table 3.1: METE Framework (Andrews, 2007b).

The METE framework, developed collaboratively and inductively over a year (Andrews, 2007b), was designed to facilitate a comparative examination of mathematics teaching in five European countries. Applied to video recordings of lessons taught on topics common to England, Finland, Flanders, Hungary and Spain the framework has highlighted both similarities in the learning outcomes privileged by teachers (Andrews, 2009a) and the didactic strategies they employ (Andrews, 2009b). Importantly the same studies have highlighted key differences in not only the privileged learning outcomes and didactics but also the ways in which such codes interact, that allude to mathematics teaching traditions unique to the countries under scrutiny. As part of this evolving research process I had every confidence in the use of this tool and with the procedure employed, adapted to the research project here. In other words, my intention was to parse videotaped lessons into episodes, defined by the METE team as that phase of a lesson in which the teacher's didactic intention remained constant (Andrews 2007 b), and then apply each code as present or not present within that episode. This would have allowed the construction of a summary of the key learning outcomes and didactic strategies privileged by teachers in each lesson.

The intention was also to compare these outcomes against the outcomes of qualitative analyses and the SRIs undertaken after each lesson. However, as I show in chapter 4, the framework proved insufficiently sensitive to the needs of my analysis and, despite its strengths in the domain for which it was developed, was subsequently abandoned.

### **3.4.3 (Video) Stimulated Recall Interview**

Stimulated recall (SR) has been used extensively in research in teaching, nursing and counselling (Lyle, 2003). Importantly, by way of warranting my research approach, ‘the study of interactive decision making has been conducted almost exclusively through the use of stimulated recall during videotaped replay’ (Housner and Griffey, 1985 p45). Moreover, Ericsson and Simon (1993) found that subjects go through the same steps whether they concurrently describe what they are doing or retrospectively describe it, implying that the delay between the lesson being videotaped and discussed in interview has minimal impact on authenticity. What is important, they argue, is helping participants remember what they have done. Moreover, Perkins (1982) describes SR as a finer-grained improvement over thinking aloud, where a participant ‘may be enabled to relive an original situation with vividness and accuracy if he/she is presented with a large number of cues or stimuli which occurred during the original situation’ (Bloom, 1953, p161). Finally, Lyle (2003 p871) highlights its limitations concerning the immediacy of the recall, and how ‘the memory accessed by the video image the potential for bias in the responses’, nevertheless, reports that the method has considerable potential for studies into cognitive strategies, in particular for ‘teacher/educator behaviour’ (p862) and the complexities of interaction in naturalistic studies.

The procedure for SRIs in this study will be negotiated with the teacher and take into account time constraints and opportunities. As soon as the digital film has been processed (as described in section 3.4.2.2) it will be sent to the teacher for her to analyse and familiarise herself with. An interview will then be booked allowing between 30 and 60 minutes, depending on the frequency of WCIT in the lesson.

During this time I will analyse the WCIT in relation to the first interview and creating questions and prompts for the SR interview. The interview will be carried out at an agreed venue, e.g. classroom after school or office or home. The important point will be to make the teacher feel comfortable and relatively relaxed as described in the previous section 3.4.2.

## 3.5 The Research Plan

### 3.5.1 Sampling: Choice of participants

As Robson (2002) highlights, sampling is an important consideration for any enquiry and depends upon the research questions and type of study. This project is a multiple case study of teachers involving interviews and observations and, as such, will employ purposive sampling strategies.

There are obvious issues to consider such as attrition of participants. This is not seen as problematic as this can be a natural occurrence in schools. This research sampling is recursive and *ad hoc* rather than fixed at the outset; it will change and develop over time. The pilot study will be sampled before the main study begins thereby informing further choice of participants. The participants will have commitments and responsibilities beyond the study, which are beyond their and my control. These characteristics and other influences which may impact on the research are grounded in 'real life' situations and therefore, cannot be prescribed, bound to or predicted. These factors, and the fact that I am not attempting to generalise, will rule out statistical sampling (LeCompte and Preissle 1993). Therefore a criterion-based selection will need to be identified for this study. This will be guided by the research questions.

- The group will be selected from primary teachers in the local area. The reason for choosing primary teachers from the local area is simply a practical one. The teachers need to be working in schools near the place of work to the researcher.
- The teachers will need to be teaching mathematics to a whole class – whole class defined as 20 children or more.
- Participant teachers will need to be able to articulate their thoughts regarding the way in which they manage their class, organise mathematics lessons, use the types of resources they use etc.
- The participants will be willing to be interviewed on their past experiences of the subject including: teaching mathematics, their understanding of the subject, their beliefs in how the subject should be taught etc.
- The participants will be willing to discuss their lessons video-taped distinguishing key features for learning and teaching strategies used to emulate the learning of mathematics.

- The participants will be willing to share their thoughts on their lessons to try to identify particular behaviours, attitudes and perhaps beliefs that might be repeated or invented during a particular or collection of lessons.

This criterion-based selection, as illustrated above, is known as *purposive sampling* (Robson, 2002). There are specific needs identified here which address the requirements set by the research questions, e.g. a confident teacher will need to be found in order to fulfil the requirements of a participant for this study, therefore a ‘good’ teacher will need to be identified and approached. A definition of what a ‘good’ teacher might be is not straight forward as there are a number of qualities to be considered and vary from different points of view, however, for the purposes of this study I offer the following definition from my experience as a teacher trainer:

- Confident in mathematics;
- An enthusiasm for learning
- A committed teacher to all learners in their school;
- a good manager of a class of thirty children;
- well organised and eager to take on new ideas to try them out;
- A willingness to be video-taped teaching;
- A willingness to discuss their practice and able to articulate why they do what they do;
- Have three or more years teaching experience;
- Interested in research

There are other difficulties in selecting participant teachers as many primary teachers feel they are already under pressure in their jobs and do not want to engage in something else that will take up their time. There will be no remuneration available to entice study participants and so *goodwill* and an interest in the research will be the major selecting factor (Patton, 1980).

Ideally *sampling typical cases*, which means a *good* teacher as defined above, will be the preferred criterion; however, it cannot be ruled out that *convenience sampling* saves time, sparing one the effort of finding less amenable participants. And, as already indicated, participant teachers will need to be confident in order to handle a deep analysis of their practice. All things considered I will endeavour to select from the following three groups:

- 1 A local authority Leading Mathematics teacher.

- 2 A recommended (by the LA numeracy team) teacher who in the team's opinion is a 'good' teacher of mathematics.
- 3 A recommended local teacher whom is known to the school of Education through its partnership scheme and known to be a good role model for trainees. Perhaps an ex-student of the mathematics specialist course of 3 years' experience or more and considered to be a 'good' teacher of mathematics.

### **3.5.2 The Teacher selection process**

Once teachers have been identified, informal contact would be initiated by telephone followed by a visit to the school shortly afterwards to discuss the research objective and procedures. An agreed time would be fixed to allow a 'cooling off' period and then a letter would be sent from the university requesting the teacher's, the head teacher's and parental consent to video-tape the lessons.

When all issues (if any) have been addressed, a date would be fixed for a 'mock' video-taped lesson to familiarise the teacher and his or her class with the equipment during the course of a lesson, to allow me to practise setting up the equipment and to test that it is working correctly. Often the free-standing microphone will be tested in different positions to achieve the 'best' sound feedback.

In light of the issues raised above I decided to test the tools in a pilot with two teachers. The main study involved a further four teachers.

### **3.5.3 Credibility, generalisation and Validity**

It is important that researchers examine questions of generalisability, validity and reliability to ensure that credible data are produced and outcomes warranted (Denzin & Lincoln, 1998). Unlike the explicit objectives of quantitative research, which are generalised statements about a particular population based on controlled pre-determined variable, case study does not set out to generalise but provide in-depth accounts of the phenomena under scrutiny (Yin, 2009). This does not mean that some form of generality cannot be inferred, although the manner in which the process is undertaken requires careful management. Indeed, Flyvbjerg (2006, p220) argues that such received wisdom, that case study cannot contribute to generalisations, "if not directly wrong, is so oversimplified as to be grossly misleading", arguing that it is not true that a case study cannot provide reliable information about the broader class". He adds that even science, with its high expectations of rigour and random samples, is littered with examples of single cases being accepted as general scientific truths; it all "depends on the case one is speaking of and how it is chosen" (Flyvbjerg, 2006, p225).

In terms of the processes by which case study may contribute to generalities, Deising (1972) has suggested that generalisations can be legitimately made by integrating both uniqueness and regularity, the particular with the universal. Of particular relevance to this study, Giddens (1984) has argued that research focused, essentially, on hermeneutical problems or textual interpretation, may be of general importance in its eliciting agents', in this case teachers', knowledgeability and, therefore, their warrants for their actions. More generally, Stake (2002) suggests that naturalistic generalisations can be made by identifying similarities between issues in different contexts. In this respect Tripp (1985, p35) offers a helpful distinction between metaphoric and literal similarity, arguing that "a literal similarity statement succeeds or fails both on account of the match of features in the known to the unknown entity, and also in terms of a match in the levels of salience between the two". Thus, understanding the process by which literal similarities may be identified facilitates another key aspect of generalisation in qualitative research in general and case study in particular; the extent to which studies over time offer cumulative support for a particular result, although such a process is typically hampered by the idiosyncratic nature of much case study research and its failure to adopt common forms of presentation (Stenhouse, 1978, Tripp, 1985). Interestingly, in terms of presentation, Bassey (1999) argues that a slight shift in the wording of one's research findings by means of the inclusion of qualifying verbs like 'may' allow researchers, through the presentation of 'fuzzy generalisations' to shift beyond the particularities of a case by inviting the reader to speculate with the researcher.

In sum, while one must always exercise caution with respect to case study and generalisation, it seems clear that it may be possible, given propitious research design and data analysis, to make statements that others would recognise as having a broader truth than just within the context of the case from which they derived. It is with this in mind that this study is framed.

Other researchers offer a range of approaches with regard to the validation of qualitative methods (LeCompte & Preissle, 1993; Maxwell, 1992). The most important of these seems to be that I remain systematic in my approach and fair and just in my representations of the 'reality' or research phenomenon. Issues of validity can also enter at every stage of a piece of research (Cohen, 2000). Therefore, an attempt to 'build out' invalidity is essential if I am able to have confidence in the research plan, data acquisition, data analysis, interpretation and its ensuing judgement. These issues will be addressed latter in this chapter.

Reliability, which Cohen et al. (2000) present as a synonym for consistency and replicability over time, over instruments and over groups of respondents, is concerned with precision and accuracy through stability, equivalence and internal consistency. These aspects will be addressed in a number of ways, not least of which will be consistency of approach in the manner of data collection and the means by which data are analysed and reported.

### **3.5.4 Ethical Considerations**

The ethical principles underpinning the British Educational Research Association (BERA) 2011 guidelines will direct this study within an ethic of respect for:

- The person
- Knowledge
- Democratic values
- The quality of educational research
- Academic freedom

In addition, drawing on the relevant issues highlighted by BERA, responsibilities to participants will be acknowledged, whether they are active or passive subjects of the observations and inquiry. Thus, the following responsibilities will be assumed by the researcher:

Voluntary informed consent will be sought from all participants prior to the research getting underway. This will include a consent form from the participant teacher, the head teacher of the schools taking part and the permission of the parents of the children who are in the participant's class.

Steps will be taken to ensure that all participants understand the process in which they are engaged, including why their participation is necessary, how it will be used and how and to whom it will be reported.

Deception and subterfuge will not be a part of this study and the researcher will actively work to make sure this does not happen throughout the study. The right of withdrawal is recognised as the right of the participant for any or no reason and at any time. Each participant will be informed of this right from the outset of the study. No coercion or duress will be used to persuade participants to re-engage if the participant has made the decision to withdraw.

Children will be 'secondary' subjects within the study as typical mathematics lessons will be recorded as part of the data gathering process. Articles 3 and 12 of the United Nations

Convention on the Rights of the Child will be obeyed at all times during the study by the researcher and any collaborators or other participants involved. I will comply with legal requirements in relation to working with school children Confirmation of a recent CRB Criminal Record Bureau check is held by the University.

I recognise that participants may experience distress or discomfort in the research process and will take necessary steps to reduce the sense of intrusion to put them at ease and will desist immediately from any actions, ensuing from the research process that may cause emotional or other harm.

Every precaution will be taken to minimise the normal working and workload of all participants. No incentives will be offered to the participants other than to seek knowledge and understanding of their own practice and the potential to inform educational researchers.

Clear and transparent information regarding any detriments that may arise whilst the research takes place and any which may arise during the research will be brought immediately to the attention of any parent/guardian/carers before and during the research process. Consideration and any action will be taken to minimise the effects of designs that advantage or are perceived to advantage one group of participants over others.

The confidentiality and anonymous treatment of participants' data will be kept by the researcher and supervisors at all times recognising the participant's entitlement to privacy. Conversely the researcher recognises participants' rights to be identified with any publication if they so wish. The Data Protection Act (1998) and any subsequent similar acts, entitles people to know how and why their personal data is being stored. The researcher will seek participant's written permission to disclose personal information to third parties. All data kept will be securely stored under lock and key in the researcher's office at the university. It will be considered good practice to debrief participants at the conclusion of the research and to provide them with copies of any publications arising from their participation.

### **3.6 Research Framework**

This section presents the schedule and data analysis procedures employed in the study. The process will be repeated for every teacher participant in two phases: Phase one will pilot the

instruments working with two teachers followed by Phase two, where data from four teachers will be gathered repeating the procedures, or a refined version of them.

### 3.6.1 Phase one: Pilot Study

The pilot study is to test out the *instruments* and *tools* (as described above) used to gather information by the researcher. Lincoln & Guba (1985, p201) describe the effectiveness of a *Purposeful sampling*, comparable to Glaser & Strauss' (1967, p48) *theoretical sampling*. Its purpose is to maximise information, not facilitate generalisation through an inductive data analysis, as described by Lincoln & Guba (1985), where two essential sub-processes are involved; 'utilising' (a process of *coding*; according to Holsti (1969) and Krippendorf (1980) and 'categorising' which has been well illustrated by Glaser & Strauss (1967) under the heading of a 'constant comparative method'. This method has been used extensively by the 1999 TIMSS video study (Stigler & Heibert, 1999) which was described as a 'bottom-up' analysis of 'whole-class' interaction through Argyris and Schön's (1974) a 'theory of action' being what you say you do in contrast to their 'theory in action', what you are observed to do, approach. The pilot study is essential to distinguish a body of knowledge of a set of appropriate procedures which the researcher will need to develop, trial and improve to inform the main study.

The table below (3.2) illustrates how the research questions are related to the methods employed and method of analysis matched to the stages of procedures.

| Questions  | Method of data collection   | Method of analysis                  | Stage | Procedures  |
|--|-----------------------------|-------------------------------------|-------|---|
| How do primary teachers of mathematics conceptualise the whole class aspect of their work? | Semi-structured Interview   | Constant comparison method employed | 1     | Teacher selection in pilot study                                    |
|  |                             |                                     | 2     | Transcript of interview analysed and teachers' beliefs categorised. |
| What justifications do they  | Stimulated Recall Interview | Constant comparison                 | 3     | Video-tape lesson: analyse and formulate questions for SRI          |

|   |                                    |  |   |  |
|---|------------------------------------|--|---|--|
| present for their actions?                                      | (Semi-structured)                  | method employed                                    | 4 | SR interview<br>Transcribe tapes & Analyse teachers thoughts & ideas                     |
| What knowledge and beliefs underpin those actions?              | Observation of video-taped lessons | Sayers (2007) Framework<br><br>Constant comparison | 5 | Analyse teachers responses with WCIT (strategies, affordances & constraints) &           |
| In what ways do the espoused beliefs resonate with the enacted? | Observation of video-taped lessons | Constant comparison method employed                | 6 | Analyse teachers responses with WCIT with belief systems identified in initial interview |
|   |                                    | And METE (2005) framework: (quantitative)          | 7 | Review, analyse & quantify video-recordings with analytical framework                    |
|   |                                    |  | 8 | Interpretation of the data findings  |

Table 3.2: Overview of stages of procedure

### 3.6.1.1 Stages of procedure

An articulation of the eight stages of research procedure will now be presented in the table presented above (table 3.2).

#### Stage one: teacher selection in pilot study

The two teachers selected for the pilot study were white English heritage with a British home culture: Abbie and Beth. Abbie had four years teaching experience and was a first class degree mathematics specialist at the University of Northampton. She had just been given the role of Numeracy coordinator and was in the process of becoming a DfES 'fast track' teacher. She talked very passionately about her subject and about her school's aim of improving mathematical achievement in KS1. Her class were 29 year 2 children (aged 6-7yrs).

The second teacher had over twenty years of experience in the classroom. She presented herself as an 'Early Years' specialist as that was her preferred age phase, but qualified as a geography specialist and married a mathematics specialist primary teacher and thereby

became interested in the subject. She was the Numeracy coordinator and deputy head of an urban estate school demonstrating ‘new town challenges’ and attendance difficulties. She was currently working in a year 3 class three days a week and two days performing deputy head duties. She explained that she taught the same class since year 1 which was considered by the school staff to be a ‘difficult’ class to manage behaviour. Although the teacher was not keen on the arrangement, she felt happy with the situation as she ‘knew the children well’ so only teaching them three days a week, which included all the literacy, science and mathematics they worked on in a week. The other teacher taught most of the foundation subjects e.g. history and geography.

An interesting aspect to the second teacher, in particular, is her claim to ‘know the children well’ for according to Watson (2006) ‘no teacher can know fully a learner’s capabilities and potential’ (2006, p78) where teachers make judgements about learners as they can ‘easily imagine they know things about a learner’ (2006, p78) in a classroom situation. Watson’s work was in a secondary school where teachers see pupils regularly every week and sometimes for years. However this is a primary school where a teacher teaches her class, usually, for every subject, it will be therefore an interesting consideration to understand how a primary teacher conceptualises her knowledge of the children in her class.

### **Stage two: immersion**

The aim at this stage is to develop a ‘good’ relationship or ‘rapport’ with the teacher, just as Glesne (2005) recommends. After an initial telephone conversation I will arrange to meet the teacher after school in her classroom and present what the research study aims are, my interests and my background. Ethical issues will be discussed at length and consent forms agreed together with where a single camera might be set up and possible dates for the six lessons to be video-taped.

A second meeting will be made to conduct the semi-structured interview with the teacher which will approximately take an hour including setting up introduction, testing and putting away. The questions devised for this interview can be found in appendix 3.2.

The aim of the instrument is to gather rich data that represents a balanced account of teachers’ beliefs about their relationship with the subject of mathematics and the teaching of it. The interview will be transcribed and then reviewed and analysed in order to develop questions for the next stage

### **Stage three: Immersion**

Stage three involves video-taping a lesson, and processing the digital film followed by multiple viewing of the video recording to identify particular instances, gestures, resources used and emphasised by the teacher and anything that could be described as a significant ‘moment’ including confirmation or contradiction of and beliefs the teacher had given in the initial interview. Also explanations of strategies the teacher used in the lesson will be discussed where affordances and constraints offered to the children from a mathematical perspective (e.g. why did you use 2-digit numbers in that example given to the class?) will be noted. These events will be analysed and questions constructed to ask the teacher in the stimulated recall interview that would follow.

### **Stage four: Immersion**

Stimulated recall interview will be recorded. This will take between twenty minutes and sixty minutes. The digital tape will be processed and transcribed and checked with the teacher for verification.

Stages three and four will be repeated for every lesson observed and recorded.

### **Stage five: Categorisation**

Each SRI transcript will be analysed against the recorded lesson. Here the events of the lesson will be analysed with the justifications the teacher offered in the SRI. This requires multiple viewings of the observations and interviews where codes and themes will be identified until reaching saturation. While the codes emerge from the data, existing theory and strategies from the literature will also be explicitly used to compare and contrast with the practice and with each lesson.

### **Stage six: Phenomenological reduction**

Following the initial coding of the data, strategies, affordances emphasised and constraints made by the teacher will be grouped together to reveal themes. Stage three is concurrent with stage two. Themes will be defined and when a code emerges that does not fit into existing groups, a new group will be formed. This allows a continuous process of refinement.

### **Stage seven: Triangulation**

Examples of each code will be selected and cross-referenced with each of the teacher's beliefs and attitudes identified in stage two. The video recordings will then be reanalysed using the analytical framework developed by METE project. The results of this analysis will be analysed as appropriate.

### **Stage eight: Interpretation**

A conclusion to the methods of data collection will be analysed and presented. I will portray each teacher participant's views together with the conclusion to how primary teachers of mathematics conceptualise WCIT. This will be forwarded to them for their information. These individual 'stories' will also be compared with each other participant teacher and any conclusions presented. Other findings will be presented e.g. there will be a review of how the teachers studied, reflect the 'emphasised' teacher model offered by governmental guidance/training to all primary teachers in the teaching of mathematics and any conclusions drawn.

#### **3.6.2 Phase Two: Main Study**

The main study will be carried out with four further teachers. It is designed to use the instruments developed and defined from the pilot study together with the trialled competences of the researcher, to develop a framework from which the conceptions of the case study teachers' understanding of WCIT can be analysed. The data from the pilot study also has the potential to be used in the development of the framework if appropriate. The procedures presented in eight stages earlier in table 3.2 will be repeated for each of the teachers in the main study unless refinement has been made to this in the pilot.

Phase two teachers will be selected against the same criteria as for the pilot described earlier. Details of each teacher in phase two will be presented in their respective case chapters.

## Chapter 4 Phase One of Study

### 4.1 Overview

The first phase of the study was a case study analysis of two primary teachers' backgrounds, beliefs, attitudes and practice in relation to their conceptualisations of the whole class interactive phases of their mathematics lessons. As indicated above, there have been many studies (Leinhardt, 1988; Carpenter & Lubinski, 1990; Reynolds & Walberg, 1992; Thompson, 1984; Skott, 2004) examining how teachers' beliefs are reflected in their practice, but few have addressed the relationship specifically between teachers' beliefs and practice with respect to the whole class interactive phases of their lessons. In this chapter, an initial, pilot, exploration of the relationship between the two teachers' whole class teaching-related beliefs and practice is presented. In so doing I examine the efficacy of several extant frameworks for analysing classroom practice.

The first phase of this study is reported in its entirety, together with the conclusions and implications that will inform the second phase. The reader is reminded that data were collected in three forms. Firstly, both teachers, Abbie and Beth, undertook semi-structured interviews prior to being observed on six occasions. The observations, which were videotaped, formed the basis for video stimulated recall interviews in which informants were presented with opportunities to discuss and explain their thinking with respect to key incidents in the lessons under scrutiny. All interviews were videotaped and all videotapes were transcribed.

The preliminary semi-structured interview typically comprised around twenty questions, although not all were asked as responses to one may have occurred naturally in response to another as conversation developed. The questions were based on four broad themes, as shown in table 4.1, derived from Andrews' (2007a) life history interviews of English and Hungarian teachers of mathematics.

|   | Theme                           |
|---|---------------------------------|
| 1 | Personal Experience - subject   |
| 2 | Personal Views - teaching       |
| 3 | Personal Preferences - teaching |
| 4 | Personal Reaction - curriculum  |

Table 4.1: Interview themes of questions based on (Andrews 2007a)

The full schedule can be seen in appendix 4.1.

The SRIs were also semi-structured but each was uniquely structured according to the issues that emerged as the video was observed prior to the interview itself. In other words, each SRI reflected my perceptions and emergent interests.

This chapter is presented in five parts:

1. Background of teacher participants
2. Teachers' beliefs and their perspectives on practice
3. Theory driven approaches to analysing classroom practice
4. Data driven approaches to analysing classroom practice
5. Discussion and implications for phase two of study

## 4.2 Background of teacher participants

In order to understand as fully as possible teachers' mathematics-related beliefs and practice, it was thought appropriate to ask both participants to talk about their early recollections as learners of mathematics, their experiences of school and their professional preparation as teachers. In the following I present data pertaining to teachers' backgrounds derived from these semi-structured interviews. The teachers' utterances are presented in *italics*.

Abbie's recollections of her time in school were of her being very good at mathematics. She remembered fondly some of the teachers that had taught and inspired her. Although neither her mother nor her father was very good at mathematics, she knew that they were both very proud of her for doing so well in the subject. She said *I don't remember specifically doing maths as an infant*, but did remember enjoying the subject in junior school. *I remember ...the teacher made us a times-table challenge, something was going on with Everest (the mountain) at the time and she made base camps (on a wall display), and you moved onto the next camp if you could do the times tables.* Abbie also remembered being successful at secondary school, although she recalled some upsetting and negative experiences instigated by, she thought, insensitive teachers' responses to her being good at mathematics. She mentioned, in particular, a physics teacher who, on one occasion, commented, in front of her class, that *he could not draw a perfect circle on the board, no one could, oh unless Abbie can.* She spoke about how shocked she was by this and how she could not understand why he had said that, believing the *he was putting me down.*

She also commented, due to her being in the top set for mathematics, that she had to take her O level examination early. This she felt had damaged her opportunities thereafter, not least because she did not do any further mathematics for nearly a year, when she began her

A level course. She added that the teacher who took her at this time was straight out of training college and could not answer her, or her peers' questions. Consequently, she left school before completing her studies, feeling angry and frustrated at the manner in which she felt she had been let down. She conveyed much sadness and frustration over this experience and did not return to any study of mathematics again until she returned to studying as a mature student after she had married, when she completed a three year BA (Bachelor of Arts) with QTS (Qualified Teacher Status) with a mathematics specialism. This, she said, rekindled her love of mathematics. For the first time in many years she enjoyed playing around with numbers and shapes. She said she had *really positive feelings about the subject; I have always just loved maths!*

Beth had a very different perspective on the subject. She said that although she *enjoyed mathematics* (at school), she *never felt it was a natural subject* for her. She commented that *I was always more interested in English, the arts and geography. I didn't despise it, I did not excel at it, I coped with it. It was just one of those things I did.* Although she was successful at school, she did not remember having any inspiring mathematics teachers. She noted that she knew she *had to do it to become a teacher* and so she just *got on with it*. Her inspiration for the subject came when she met, at university, a man whom she married after she had qualified to be a primary teacher. He had also trained to be a primary teacher but was very excited by mathematics. She said *we had to have mathematics lessons at college, I just had an interest in the whole package of being a primary teacher, mathematics was part of that package, but because I had met my husband at college I wanted to find out about his interests and experiences.* She believed it was at college that she became interested in the subject, due to the *knock-on effect* of her personal relationship.

In summary, Abbie presented herself as someone who had always had an affinity with and succeeded at mathematics. She had experienced periods of frustration born of circumstances beyond her control but, in general, she had retained her passion for the subject and could recall enthusiastic teachers who inspired her. Beth, on the other hand, had no such passion and although she was a competent student, it was not until she met her husband that mathematics became anything but a necessary evil. However, in relation to Abbie's clearly articulated excitement, Beth's relatively late acquisition of enthusiasm appeared more strategic than persuaded. Such experiences, as will be shown below, influenced greatly how the two teachers approached their work. This is particularly pertinent

as both, with their very different perspectives on mathematical enthusiasm, had become the numeracy coordinators of their respective schools.

#### 4.3 Teachers' beliefs and their perspectives on practice

The preliminary interviews also yielded data on participants' beliefs about mathematics, its teaching in general and the role of whole class interactive episodes. The following is based on these data.

Both teachers believed that the introduction of the NNS (DfEE, 1999) was a very helpful initiative, particularly in the ways it supported colleagues with, relatively, weak subject knowledge. In this respect Beth discussed at length how much of her current role, as *numeracy coordinator*, was to support those weaker teachers and to help them deliver what she referred to as *the whole package*. Part of this approach, she said, was to help them ...*just go through the motions and break it down into manageable chunks* so that they could teach it and then move onto the next stage. These were interesting perspectives for at least two reasons. Firstly, she referred to mathematics as *the whole package* on more than one occasion but never indicated what she meant by it, seeming to assume it to be a commonly understood phrase which I infer to mean the content, processes and pedagogy of mathematics teaching. Secondly, her phrase, *just go through the motions*, seemed to imply a very mechanical and procedural view of mathematics teaching.

Both teachers were invited to talk about how they approached their teaching of mathematics. The invitations incorporated several predetermined foci. One of these related to their practice and practice-related beliefs in relation to the different lesson parts as highlighted in the expectations of the three-part lesson of the NNS (1999) guidance. This was to see whether they believed the different parts had different purposes, and which, if any, were significant in respect of the explicit research focus of whole class interactive (WCI) teaching. Other foci related to what Beth and Abbie believed were personally important about the teaching mathematics; those topics they enjoyed teaching, their preferred environment, their perceptions of the strengths and weaknesses of the curriculum and what they believed were their approaches to teaching mathematics. Four key aspects relating to how they described their beliefs, attitudes, and preferences to the teaching of mathematics to their classes emerged. These were:

1. Lesson structures
2. Teachers' aims for mathematical learning

3. Strategies used to present and teach the subject
4. Attendance to social disposition of the children

I will now take each of these aspects and discuss the findings.

#### **4.3.1 Lesson structures**

Both teachers talked about the three-part structure (OMS, main, plenary) of their mathematics lessons. However, Abbie indicated that she frequently conducted plenaries throughout as well as at the end of her lessons. In such circumstances she would stop the lesson to discuss progress and problems with the class. Beth talked about how she always tried to begin her lessons in a *bright and breezy* manner, in order to *get their brains working*. She added that, *to get them motivated we often play little games to get them inspired... right frame of mind*. She also talked about ending the lesson '*with some sort of fun activity so we end on a high point*'.

Interestingly, Beth, the more experienced teacher, talked much about each section of the lesson and her aims for it. For example, she said in respect of the main part of a lesson that

*the whole class is doing the same activity but just slightly tweaked for each group. Sometimes a group will be working on a different aspect. I usually go and work with a group so it is a teacher directed activity. And then we conclude at the end by bringing together our thoughts, quite often use that for anything that has come up in the lesson and I often stop the lesson as well if something has become apparent that the children are not understanding, very often a teaching point is made half way through the lesson but the plenary is the time to reflect on what we have done. Sometimes taking the learning a little bit further, asking them a searching question ready for the next lesson and getting them prepared for what we are going to do next.*

Embedded in such comments was a clear sense that Beth saw differentiation as a guiding principle for her actions tempered by a collective reporting and discussion of emergent issues, in a similar fashion to Abbie that was not necessarily restricted to the closing plenary.

Both teachers described how, due to a government initiative in 2001 (OfSTED, 2002; BECTa, 2002) to improve ICT in schools, interactive whiteboards had recently been installed in every classroom and how they wanted, as a consequence, to use these and other practical equipment whenever they could. Both also indicated that their children were very excited by this new equipment, highlighting further their imperative for working with it.

In sum, Beth was articulate and aware of what she believed was the purpose of, and what she did in, each section of her lesson. Interestingly, Abbie said much less in this respect, which may be indicative of her not being used to articulating her perspectives on such

matters. That said, neither teacher offered a clear rationale, beyond what was said in the NNS guidance, for their use of a three-part structure, although both believed it was a *sensible* approach.

### 4.3.2 Teachers' aims for mathematical learning

Beth explained that a key aim with respect to her teaching was *to change children's understanding of maths ... to get them to think about things and explain things*. Interestingly, in the light of the discussion above, she added that *the whole package is to make everything fun and exciting for them and at their ability levels as well*. She talked much about how she thought aspects of the NNS framework constrained what she was able to do. For example, she believed that both pattern and geometry were not well represented in the curriculum and yet she had spent much of her career teaching in key stage one and knew, from experience, that children were able to work with such topics in meaningful ways beyond current curricular expectations.

Beth spoke of three additional aims with respect to her children's learning of mathematics. Firstly she believed it was important that children should acquire ownership of what they were doing, commenting that, *children gain more if they take things through themselves and not rely on us*. Secondly she talked about how important it was to identify and discuss as a class children's misconceptions. Thirdly, she spoke about the importance of using appropriate vocabulary as a key component of mathematical learning. She also indicated that she attempted to develop mathematical understanding in her children, but this was implicit in comments relating to pedagogy. Consequently, this will be discussed in the next section.

Abbie, as before, had less to say, although she commented that *I think part of me is wanting to make it (mathematics) real world for them*. That said, she seemed confident that her children's experiences of school and beyond had already located much learning in this manner. She commented, *they are already doing it ...then from that they start looking at what they are already doing ...that feeds into their understanding of different concepts*, highlighting her belief that conceptual development is contextually located. She went on to confirm that it was important for her to support her children's understanding through *knowing why they are doing it*. Abbie also mentioned her desire to develop children's independence as learners, but did not articulate how she did that, or indeed why. Finally, Abbie's only other explicit reference to mathematical learning emerged through an assertion

that she paid particular attention to challenging children, implying an emphasis on mathematical thinking, and is something to which I return later.

In sum, both teachers talked very little about the development of mathematical learning but much about their approaches to the teaching of the subject, which is the thrust of the next section.

#### **4.3.3 Strategies used to present and teach the subject**

Beth was an experienced teacher who indicated that she often talked to her colleagues, in her capacity of numeracy co-ordinator, about strategies used to teach mathematics and, in so doing, made extensive use of the NNS (DfEE,1999) materials. Abbie, by way of contrast, had been a teacher for just four years and was in her second year as numeracy co-ordinator. This may account for the difference in what the two teachers talked about, or were aware of, their own practice. However, the strategies they both explicitly referred to in the interviews will now be presented and discussed.

Both teachers, in relation to the OMS, talked about reactivating their children's knowledge, believing it to be an important part of every lesson. Interestingly, however, neither teacher talked about prior knowledge in relation to any other part of the lesson. More generally, both teachers mentioned a variety of strategies which, in the light of the dominance of the NNS, were also found in the NNS guidance. Moreover, both described their strategies in relation to what they expected would be seen in their observed lessons. On occasions, their descriptions were similar to each other and reflected the vocabulary of the guidance paper, as with, for example, their descriptions of strategies like questioning and discussion. On others the resonance was less obvious and with others still, the two teachers had very differing perspectives.

The most significant difference between the two teachers' approaches was found in the use of the word explain. Beth offered a very detailed description of *explanation* as a teaching strategy, while Abbie only ever referred to explaining as something her children did as part of their sharing of their thinking with others. Beth spoke much about explaining, describing how she would explain learning objectives, success criteria and the key vocabulary her children would be learning.

Other strategies of interest included differentiation, motivating and the use of resources. All three are implicit in the NNS framework although both Abbie and Beth discussed all three explicitly. Both were clear on the difficulties that differentiation can create in their planning

and teaching because of the *wide range of abilities in the class*. Moreover, their choice of vocabulary - *supporting* low-ability children and *stretching* the more able – clearly presented different perspectives on how they saw themselves in relation to this aspect of their work. In similar vein, both described how they use *good resources* to motivate not only their children's engagement in mathematics but also their understanding. Both talked much about the importance of motivation, particularly Beth who believed that her children, from low socio-economic backgrounds, needed to be motivated to learn. In this respect, she often spoke about, for example, her use of resources, ICT, small white boards to motivate her class.

In sum, the interviews revealed not only that both teachers espoused the use, in general terms of similar teaching strategies, and that frequently these were resonant with those of the NNS. In addition, both were conscious of the role of children's attitude and social disposition towards mathematical in the construction of learning, and the following addresses this more fully.

#### **4.3.4 Attendance to social disposition of Children**

As indicated above, Beth saw encouraging her children to *become active learners* as an important part of her role. Abbie, too, talked about developing independent learners in her class, but could not elaborate on what she meant by that. These responses were typical of the two teachers. However, Beth was more experienced and this could be a factor in why she had more to say. Interestingly their foci on the enjoyment and motivation of children arose in different ways. Motivation has already been discussed as a pedagogic strategy, but is presented here as something different. Both talked about the importance of *knowing their class* and *responding to the class' needs*, which is neither a mathematical learning intention nor a pedagogical strategy. My interpretation is that it relates to their professional beliefs (Bohl & van Zoest, (2002) and may allude to the communities (Lampert, 1990) or environment (Malaguzzi , 1998) teachers try to create in their classrooms.

Both, acknowledging that negative attitudes, once developed, may militate against learning, talked about the importance of lessons that were *fun*. Abbie, for example, talked about how she liked to begin *every lesson with something fun like the use of a game to prepare the children for the lesson, and using puzzles to make it fun*. She said she liked to *find ways of getting into the children's world to make it practical and helping them to believe they can do it*, she went on ...*cus I think maths is the area of the curriculum that stands out far stronger*

*than any other, ... children will say I can't do it I'm rubbish, and to get them to see that they can do it, be able to build children's confidence in it, I love that side of it. Just to be able to build their confidence to take on an investigation.* Again she seemed to be saying that she was trying to develop independent learners, not dependent. Indeed a plenary was an opportunity to reflect on what the class have been doing in the lesson, and therefore she would not simply choose a group to present their work at the end, she said *there is no point in celebrating one group's successes to frustrate another*. Beth too talked about the need to proactively engage all children in the lesson, commenting that *some children will just sit quietly, unless you are an experienced teacher, children will not join in*. Interestingly, and on an entirely different tack, Beth commented, with disappointment, on how some of her colleagues punish misbehaviour with extra mathematics, saying, *I think oh, no, it just goes against everything that you are trying to teach and it is really, really common that maths from a really early age maths is not fun.*

In sum, in their enthusiasm to facilitate children's engagement with and enjoyment of mathematics, the views of both teachers appeared to be similar. In related vein, both spoke about the need to attend to their children's emotional responses and were clearly aware of the complexities of developing children's positive attitudes towards the subject. This attention to children's attitudes is not an unexpected emphasis from enthusiastic teachers who were leaders of the subject in their schools. It would therefore be an interesting aspect to observe the ways in which they develop these attitudes in whole class phases of their lessons.

#### **4.4 Theory driven approaches to analysing classroom practice**

In terms of analysing videotaped lessons it was suggested in the methodology chapter that the analytical framework developed by the mathematics traditions of Europe (METE) project team (Andrews 2007b) would be used. This framework, developed for use with videotapes gathered as part of comparative examination of mathematics teaching practices, offers a distinctive set of seven generic learning outcomes and ten generic didactic strategies. It has been used successfully in highlighting both similarities and differences in how teachers in England, Flanders, Hungary and Spain undertake the teaching of mathematics (Andrews 2009a, 2009b). However, as I show below, once used on case study data of the form collected in this study, too little of Abbie's and Beth's practice remained hidden from analytical view. Consequently, other frameworks, such as those of Askew et al (1997) and

Kilpatrick et al (2001) were examined. Similar problems arose, highlighting the need for a data driven rather than theory driven analysis. In the following I outline the analytical process leading to this conclusion.

Table 4.2 shows six of the seven generic learning outcomes of the METE framework. The missing outcome, derived knowledge, had been shown in earlier studies (Andrews 2007b, 2009a) to be too rare to be worthy of inclusion.

|                                |   |
|--------------------------------|---|
| <b>Mathematical Focus:</b>     | The mathematical focus relates to the underlying objectives of a teacher's actions and decision making. There may be more than one such focus addressed within each episode of a lesson or, in fact, there may be no such focus for a particular episode. |
| <b>Conceptual knowledge</b>    | The teacher claims or is seen to emphasise or encourage the conceptual development of his or her students.  |
| <b>Structural knowledge</b>    | The teacher claims or is seen to emphasise or encourage the links or connections between different mathematical entities; concepts, properties etc.   |
| <b>Procedural knowledge</b>    | The teacher claims or is seen to emphasise or encourage the acquisition of skills, procedures, techniques or algorithms.  |
| <b>Mathematical efficiency</b> | The teacher claims or is seen to emphasise or encourage learners' understanding or acquisition of processes or techniques that develop flexibility, elegance or critical comparison of working.   |
| <b>Problem solving</b>         | The teacher claims or is seen to emphasise or encourage learners' engagement with the solution of non-trivial or non-routine tasks.   |
| <b>Reasoning</b>               | The teacher claims or is seen to emphasise or encourage learners' development and articulation of justification and argumentation.  |

Table 4.2: Mathematical Focus

The METE descriptors were also adapted to reflect the fact that in this study teachers' espoused and enacted beliefs are under scrutiny. In the METE study only enacted behaviours were recorded. Consequently, the METE definition of conceptual knowledge, *the teacher is seen to emphasise or encourage the conceptual development of his or her students*, has been replaced by the statement, *the teacher claims to or is seen to emphasise or encourage the conceptual development of his or her students*. In similar vein, the didactic strategies of the METE project have been adapted in accordance with the different aims of this study. Details of these can be seen in table 4.3. All six lessons of both teachers were subjected to analysis against the amended METE frameworks and, in addition, provided issues for discussion during the SRIs. Structurally, each teacher's lessons fell, as they had implied they would, within the three part structure of the NNS. Occasionally there was a review between and during the three parts, but the generality was as predicted by the two teachers.

|                                   |   |
|-----------------------------------|---|
| <b>Didactics</b>                  | <b>METE:</b> Different teachers use different didactic strategies in varying proportions and in different contexts. With the exception of sharing, which is an explicit public act, all strategies could be seen in both public (whole class) and private (seatwork) contexts.  |
| <b>Activating prior knowledge</b> | The teacher claims to focus learners' attention on mathematical content covered earlier in their careers in the form of a period of revision as preparation for activities to follow.   |
| <b>Exercising prior knowledge</b> | The teacher claims to focus learners' attention on mathematical content covered earlier in their careers in the form of a period of revision unrelated to any activities that follow.   |
| <b>Explaining</b>                 | The teacher claims that it is important to explain an idea or solution. This may include demonstration, explicit telling or the pedagogic modelling of higher level thinking. In such instances the teacher is the informer with little or no student input.  |
| <b>Sharing</b>                    | The teacher claims that it is important to engage learners in a process of public sharing of ideas, solutions or answers. This may include whole-class discussions in which the teacher's role is one of manager rather than explicit informer.   |
| <b>Exploring</b>                  | The teacher claims that it is important to engage learners in an activity, which is not teacher directed, from which a new mathematical idea is explicitly intended to emerge. Typically this activity could be an investigation or a sequence of structured problems, but in all cases learners are expected to articulate their findings. |
| <b>Coaching</b>                   | The teacher claims that it is important to offer hints, prompts or feedback to facilitate their understanding of or abilities to undertake tasks or to correct errors or misunderstandings.   |
| <b>Assessing or evaluating</b>    | The teacher claims to assess or evaluate learners' responses to determine the overall attainment of the class.  |
| <b>Motivating</b>                 | The teacher claims that it is important to, through actions beyond those of mere personality, explicitly address learners' attitudes, beliefs or emotional responses towards mathematics.   |
| <b>Questioning</b>                | The teacher claims that it is important to explicitly use a sequence of questions, perhaps Socratic, which lead pupils to build up new mathematical ideas or clarify or refine existing ones.   |
| <b>Differentiation</b>            | The teacher explicitly attempts to treat students differently in terms of the kind of tasks or activities, the kind of materials provided, and/or the kind of expected outcome in order to make instruction optimally adapted to the learners' characteristics and needs.   |

Table 4.3: Didactics

Detailed analyses revealed that some of the categories were never observed in any lesson. For example, structural knowledge was absent as a learning outcome and exploring was absent as a didactic strategy. Other codes were easily identified. For example, the outcome relating to conceptual knowledge, was frequently observed in all three parts of one of Beth's lesson, as shown in table 4.4. The highlights indicate initial coding analysis of dialogue and teacher's emphasis.

| Lesson Phase  | 1: OMS  | 2: Main part of lesson   | 3: Review (plenary)   |
|---|---|--|---|
| <b>Conceptual knowledge</b><br><br>The teacher is seen to emphasise or encourage the conceptual development of his or her students. | <p>00:00:00.00 T What we are going to do today, we are going to start off by getting our brains working and we are going to actually see if we can think about the 3 digit numbers that we have been trying to look at.</p> <p>00:00:14.53 T I am going to put some 3 digit numbers on the board and the first thing that I am going to ask you to do is to see if you can read them</p> <p>00:00:23.87 T So here is the first 3 digit number WRITES ON BOARD If you think you can read that three digit number put your hand up. So here's the first 3 digit number. WRITES ON BOARD. Put your hands up if you think you know that one. Daniel?</p> <p>00:00:27.96 C 473</p> <p>00:00:35.31 T Brilliant, 473, good boy. Here is another one. Hayley?</p> <p>00:00:35.31 C 624</p> <p>00:00:47.55 T Good girl, 624. Here's another one. Are you ready Josh?</p> <p>00:00:57.42 C 312.</p> <p>00:01:01.33 T Here's a tricky one, Holly, are you looking? Holly can you tell me that one?</p> <p>00:01:03.51 C 470</p> <p>00:01:11.70 T 470 oh, be very careful, you said 470, look where you have got the TEACHER POINTS TO THE ZERO</p> | <p>00:09:08.55 T 12 good girl, we said half of 24 equalled 12. Now, what we are going to do today is we are going to do some more work with fractions. We are going to start off by doing some work on shapes. And what I want to do is ask some of you to come up here and we are going to look at some shapes on the interactive white board and I want some of you to come and see if you can write down the fraction. Now before we do this I just want to remind you CLEANS THE BOARD that when we are looking at fractions, when we are looking at pies and pizzas and cakes. If we have got a certain shape and we cut it up perhaps into 4 equal parts DRAWS A CIRCLE ON THE BOARD CUT INTO 4 EQUAL PARTS and I am going to record that as one part of four.</p> <p>00:10:08.32 T 4 parts, just like (Craig you need to concentrate) if I had four separate cakes DRAWS 4 SEPARATE CIRCLES little cakes, if I had one of those it would be one of those 4 cakes POINTS TO INDIVIDUAL SMALL CIRCLE one part of four. So we are going to have a look and I am going to invite some children to come up here and see if they can write down the fraction.</p> <p>00:10:39.36 T I am going to show you some shapes and I want you to all look very carefully. TEACHER GOES TO SET UP INTERACTIVE BOARD. Somebody has been fiddling with their things over there which they shouldn't be. You don't need to tell me who it is.</p> <p>00:11:27.61 C What fraction is white?</p> | <p>00:44:09.23 T 5, maybe you could come back to school next week with lots of frameworks to show me how you can investigate patterns. We are going to come to an end now and we are going to have a game of round of the worlds. I know it was either William or Josh.</p> <p>00:44:31.76 C Me</p> <p>00:44:31.76 T It was you Josh, so come up here Josh. Can we tuck in Hallam so that people can go round. Today's round the world (don't call out Holly, Adam put it down) Today's round the world is going to be about halves of numbers. So, I would say to Josh or to the pair, half of 8 and you will give me the answer 4, ok. So, that's what we are going to do, it is all going to be halves of numbers.</p> <p>00:45:00.46 So, pencils down Ashley and Jake. All right, do you remember (don't make faces) remember you are going to choose who you are going to have the challenges with. (Adam you are on a boat) All right Christopher, face this way half of 16</p> |

Table 4.4: Lesson analysis example- Beth conceptual knowledge

Once all lessons had been transcribed and filtered by the adapted METE framework, patterns of practice could be analysed. The SRIs were then undertaken, drawing on the video-taped lessons, to discuss and analyse those WCI-related critical moments that had been identified in consultation with the teachers concerned. Both teachers were asked to describe the episode and their rationale for doing what they did. The next stage was to analyse the observations and the outcomes of the SRIs against those of the initial interview. At this point the procedures became problematic.

The original plan had been to compare my interpretations of the observed lessons with teachers' perceptions as espoused in the preliminary interviews and explored further in the SRIs. In this manner I felt it would be possible to determine the extent of resonance between espoused and enacted practice. However, this proved to be more challenging than

anticipated, as many of the features identified in the preliminary interviews found little resonance with the categories of the adapted METE framework used in the analysis of the lessons and to structure the SRIs. Indeed, as shown in table 4.5, a number of issues emerged from the preliminary interviews that did not fit within the adapted METE framework.

| Abbie   |  | Beth   |  |
|---|--|--|--|
| <i>Teachers' utterances are recorded in italics</i>   |  |  |  |
| <b>Management issues:</b>   | <i>so much of what we do, we do because of pressure of timetable, and the children in the class, so it's to do with the management issues, not necessarily doing it the best way, and ... time constraints when you're planning. Sometimes when we go onto new strategies, those children that are just aren't ready, why even have them involved?... because it can be another frustration for them can't it?</i>   | <b>Management issues:</b><br>She believed she needed to be flexible  | Perceived constraints of time to teach mathematics the way Beth desired. She was concerned with having to use an ICT suite once a week for mathematics lessons.<br><br>Time is always an issue – particularly to include a plenary <i>because to me that rounds up the lesson, checks the success criteria, this is what we have achieved, this is what we can do, and there is your whole package.</i>                        |
| <b>Assessment focus on Differentiation:</b>   | <i>You know I've got children who ... still can't count on from the biggest number, why am I going to ask them to interpret multiplication as an array?<br/><br/>What's the benefit?</i>   | <b>Assessment focus related to the children's background?</b><br><br><i>Well it is the catchment area they come from as well, they have got very...poor literacy skills.</i> | <i>Word problems, children in our school have great difficulty in translating what is expected of a question, it is the same old thing, it is the understanding and I think that comes from their backgrounds, their poor literacy skills and listening skills so we are aiming, we do lots of work on this using ICT to make it interesting, problem solving for them. I think it is, the one that comes up all the time.</i> |
| <b>Classroom Environment:</b><br><br><b>Classroom Environment:</b><br><br><b>Use of Games:</b><br><br>Abbie's school valued play as a n approach for all year groups. | <i>Abbie focussed on Confidence and self-efficacy/attitude in mathematics. I think maths is an easy subject to kick ...there's just a general negative attitude to maths.<br/><br/>I like them to be able to discuss things when it's appropriate, it's really important to me that I have maths games, Maths challenge questions, giving them the opportunity outside of a maths lesson there are those other things to support their maths and to use their maths.</i> | <b>Classroom Environment:</b><br><br><b>Practical resources.</b>   | <i>I think all classrooms need to be stimulating and exciting.</i><br><br><br><i>Focus on ICT and use of IWB That has had a big impact on the learning of the classroom, ... we have access to Easyteach resources which are really invaluable and the children respond so well to them.</i>   |
| <b>Attention to Learning:</b>   | <i>We work with the theory that 6 year olds have an attention span of 6 minutes and 10 year olds 10 minutes so that's something we're very conscious of when they are on the carpet. I think we said 15 - 20 minutes is the most that children can sit on the carpet and ideally a lot less.</i>   | <b>Attention to Learning:</b>  | Beth was very concerned with the engagement of her children to develop active learners and stretching children.  |
| <b>Lesson Structure:</b><br>Independent Thoughts on 3-part lesson   | <i>I think there is such a pressure on teachers to make sure they're doing the 3-part lesson, I think they came from my college experience, you had</i>  | <b>Lesson Structure:</b>   | The introduction of the NNS gives you structure but, I think the learning objectives for each year group are very wide, so we like to break them down  |

|  |   |   |  |
|--|---|---|--|
|  | <p><i>your OMS, main and a plenary, and OfSTED comments on plenaries, 'oh you should have a plenary, you should have a plenary. but even though we are told at school that you can come away from those ideas, use a plenary if relevant. The plenary doesn't have to be straight after your main if you feel it's relevant to go back later to it in the afternoon do it. We are being encouraged to do that, but there is still that feeling of there should be this, then that, then that.</i></p> |   | <p><i>further. I think that is an area that we find...difficult.</i></p> <p><i>I think it was sort of prescribed to us that "this is what you will do" it was never open, from the teachers point of view. And I think you have to be, not necessarily brave, but you have to have confidence in yourself to come away from that structure. I think the structure is good for the children, that it breaks down and it is recalling information that they have done so it is like a continual spiral isn't it?</i></p> |
|  | <p><b>Concerns incl NNS:</b> And I also think that because of the way it's set up and the way it's delivered, or the way I've interpreted it is that you can actually steam through it and realise they can do ...it.</p> <p><i>I don't think it is any worse than before. There wasn't a national curriculum when I was at school so you got taught what you got taught. How can that be working any better?</i></p>   | <p><b>NNS Training of teachers:</b><br/><b>Teachers are more confident:</b></p> | <p><i>I think the training was good at the time but then you have the problems of ...very young staff ...So there is definitely a need for continuous professional development for teachers. It has given teachers more confidence.</i></p>  |

Table 4.5: schedule misfits.

Consequently it was decided that the adapted METE schedule was insufficiently sensitive to the needs of the research questions and, after exploring the viability of other possible frameworks, theory driven analyses were abandoned in favour of data driven. The rationale was that no framework had been developed to capture the complex web of detail emerging from data of such richness as that I had undertaken to collect. The METE study had been an explicit attempt to analyse lessons drawn from several countries. It had to be based on broad and inclusive categories in order to capture the ways in which different cultures privileged one more than another. With hindsight, this was clearly an inappropriate framework for a study of this nature, although much was learnt in coming to this conclusion. Other frameworks, such as the well-known strands of mathematical proficiency proposed by Kilpatrick et al (2001), were considered briefly. For example, Kilpatrick et al.'s *productive disposition* may well have captured many of the misfit categories missed by the METE framework, but, in so doing, many important distinguishing features would have been lost in a process of aggregation.

Having rejected others' frameworks as inappropriate, I returned to the literature in order to deconstruct the whole class interactive phases of lessons to see which, if any, elements were amenable to being analysed in depth and mapped across to espoused beliefs and enacted practice. The outcome of this process can be seen in the figure 4.1, highlighting well the

myriad concepts and relationships in operation at any one time, each of which has been identified as unique field of research. An enlarged version can be seen in Appendix 4.2, p304.

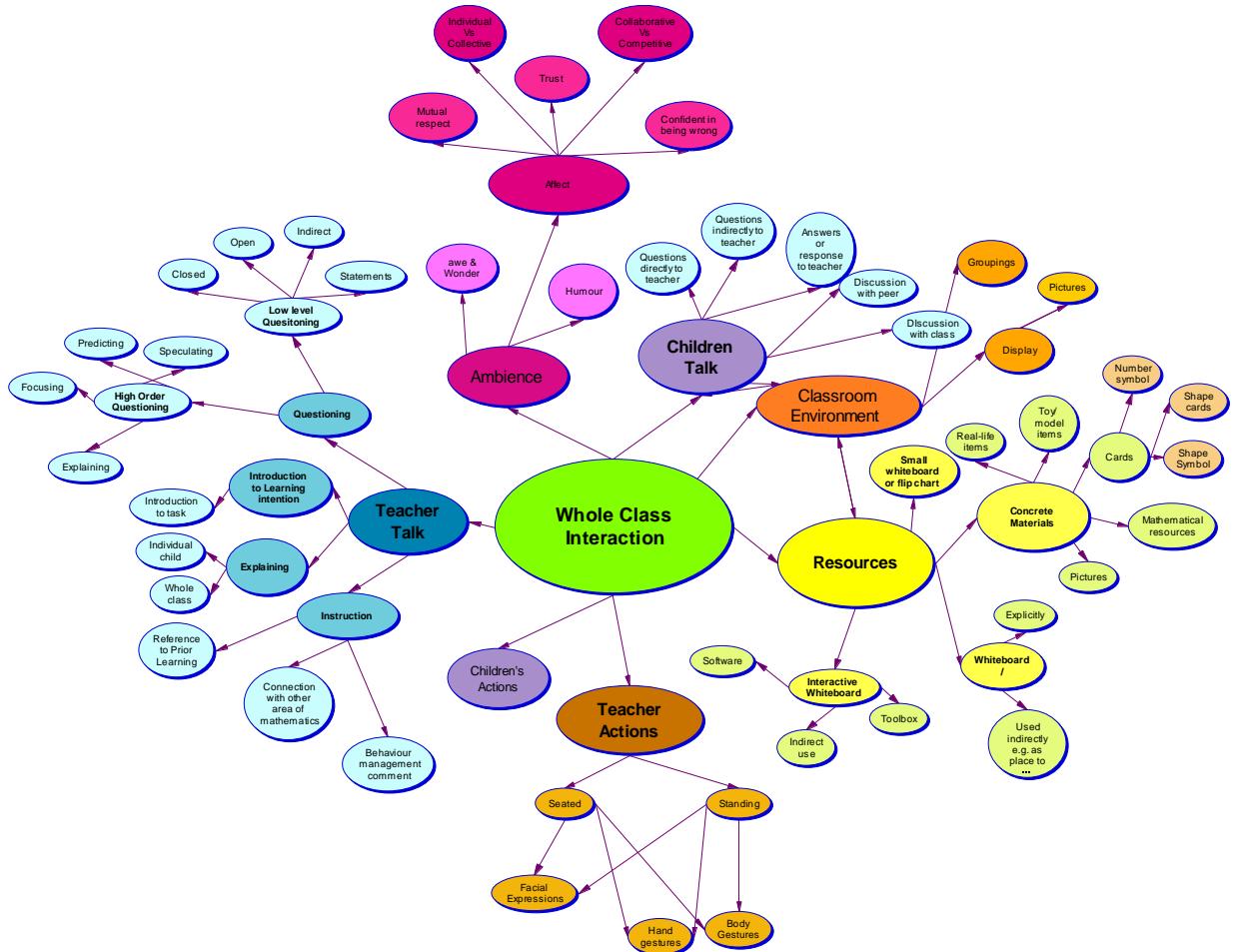


Figure 4.1: Complex web of Whole Class Interaction

To summarise, the figure above offered an impression of some of the key areas of research into classroom practice in general, and, to some extent, mathematics teaching practice in particular. The idea of attempting to capture some of these key elements was a daunting task and clearly confirmed the abandonment of pre-constructed analytical frameworks. After much deliberation, it was decided to pursue a different approach to the analysis of the data. This new approach will be discussed in the next section.

## 4.5 Data driven approaches to analysing classroom practice

The revised approach would link more legitimately the different forms of data; initial interviews, observed practice and stimulated recall interviews. Rather than apply a pre-determined categorisation to the data, it was decided to use the teacher's own utterances to highlight the resonance between espoused and enacted practice. This decision, I believe, is

much closer to the spirit of case study research, and should allow a deeper and richer description of the phenomena of interest to emerge (Yin, 2009; Stake, 1995; Gillham, 2000; Gerring, 2007, Creswell, 1998). For example, it would facilitate the identification of important patterns and themes appropriately contextualised to the cases. It would provide suitable examples from these perspectives to give texture, depth, and multiple insights. This approach is presented diagrammatically in figure 4.2. It illustrates a cyclical process whereby each teacher's espoused and enacted beliefs will be scrutinised be used as the basis of an integrated analysis with each informing the other.

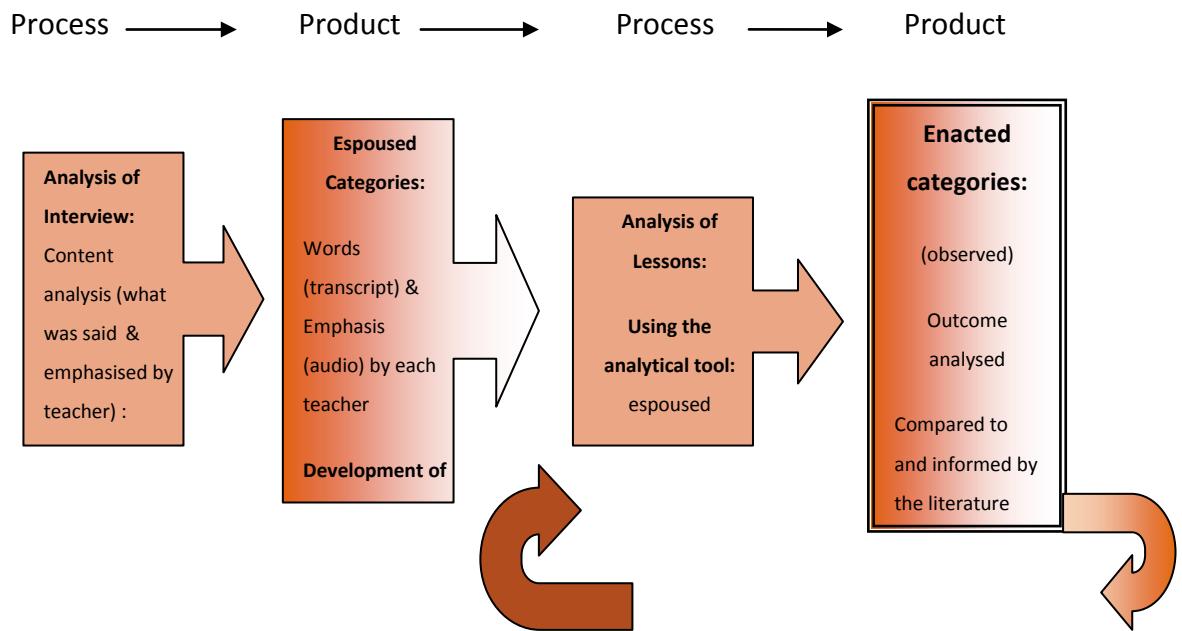


Figure 4.2: Process of analysis revised

As indicated in figure 4.2, the first phase of the analysis involved an open analysis of the preliminary interviews. Categories of response were identified, some of which were common to both teachers and others unique to individuals. These have been summarised in table 4.6. As discussed above, although both teachers used similar words their meanings were frequently different as, for example, in their use of the word explain. Importantly, the analyses of lesson observations and SRIs would now, in addition to a search for issues not raised in the preliminary interviews, seek to examine the extent to which these espousals would be manifested in practice.

| Abbie   | Beth  |
|---|---|
| <ol style="list-style-type: none"> <li>1. 6 min attention span</li> <li>2. Assess weekly</li> <li>3. Develop thinking training OMS</li> </ol> | <ol style="list-style-type: none"> <li>1. Continually ASSESS</li> <li>2. (Cultural) awareness of children's background</li> <li>3. DISLIKES word problems</li> <li>4. Explain things</li> </ol> |

|   |   |
|---|---|
| 4. Discussions<br>5. Environment maths games<br>6. Explain why doing something<br>7. Games to evoke enthusiasm<br>8. Modelling<br>9. Motivation confidence building<br>10. Ownership of learning<br>11. Practical work<br>12. Questioning<br>13. Questioning range to address all abilities<br>14. Real World context<br>15. shared experiences<br>PLENARY/REVIEW<br>16. START Introduction LO shared<br>17. Use TOOLS independently<br>18. Vocabulary around | 5. Flexible approach i.e. modelling what want<br>6. Fun Exciting Game<br>7. ICT use to make work more Interesting<br>8. IMPORTANT gap in NC geometry exploration<br>9. IMPORTANT gap in NC pattern making<br>10. Meet different ability needs<br>11. Modelling children take part active learning by all<br>12. Motivation of learning<br>13. OMS Check understanding<br>14. OMS recap previous learning<br>15. Ownership of learning<br>16. Plenary Misconceptions addressed in<br>17. Plenary round up check success criteria achievement<br>18. Plenary searching question prep for next lesson<br>19. Practical work<br>20. Question at different levels ability<br>21. RELATE new learning to other previous learning<br>22. START Share LOI and success criteria<br>23. Stretching thinking and or learning ALL<br>24. Thinking time<br>25. Visual teaching<br>26. Vocabulary |
|---|---|

Table 4.6: New Codes to analyse lessons

#### 4.5.1 Developing an understanding for classroom practice patterns

The WCI elements of each teacher's six lessons were scrutinised for evidence of her codes, as shown in table 4.6. The reader is reminded that one consequence of the abandonment of external analytical frames is that comparison across teachers becomes problematic. That is, the data driven analysis now undertaken means that different codes are being used to analyse the beliefs and practices of each teacher; Abbie's analysis drew on the left hand column of table 4.6, while Beth's the right. To facilitate this process, and the recording of codes that emerged uniquely from the observations and SRIs, qualitative data analysis software, HyperResearch, was used. This is a well-regarded tool which proved to be a more efficient and effective approach than those originally employed.

The revised approach proved helpful in yielding insights entirely located within and derived from each teacher's data. Unlike the adapted METE schedule used initially, there were no key features of observed lessons that could not be matched to a code derived from the preliminary interviews. In fact the opposite was true, there were codes yielded by the preliminary interviews that were not observed in lessons. Although I do not dwell on this here, this was an important finding in itself, particularly if we are to understand espoused

and enacted practice and the complex relationship between them. Also, although at this stage there was no particular expectation that anything significant would emerge from the process, other than to test the tool for effectiveness, patterns of practice began to present themselves very quickly. Indeed, as can be seen in the following graphs (figures 4.3 to 4.8 – Abbie and 4.9 to 4.14 – Beth), a relatively small number of codes identified in each preliminary interview were observed with regularity across each teacher's lessons.

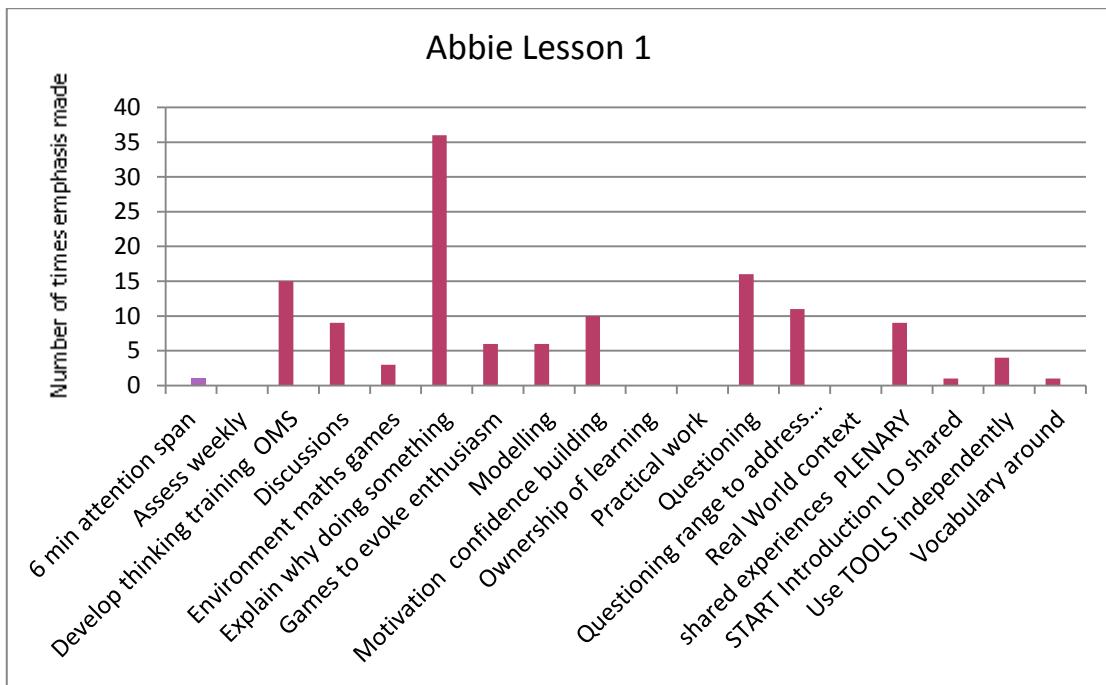


Figure 4.3: Frequency of codes Abbie L1

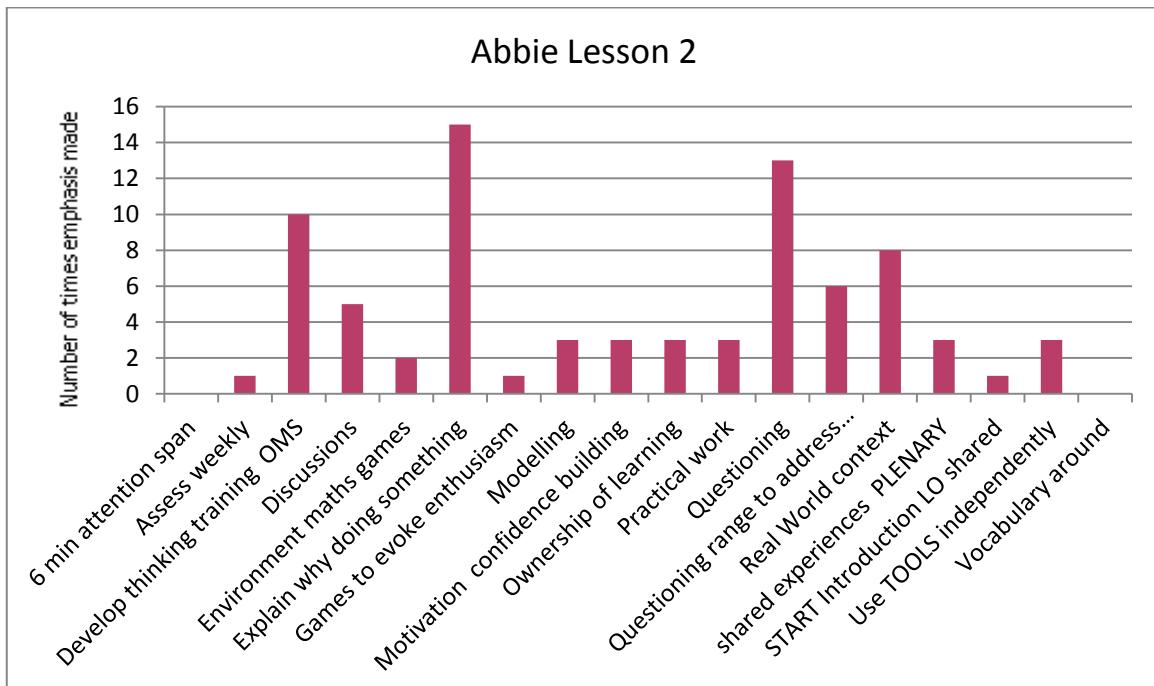


Figure 4.4: Frequency of codes Abbie L2

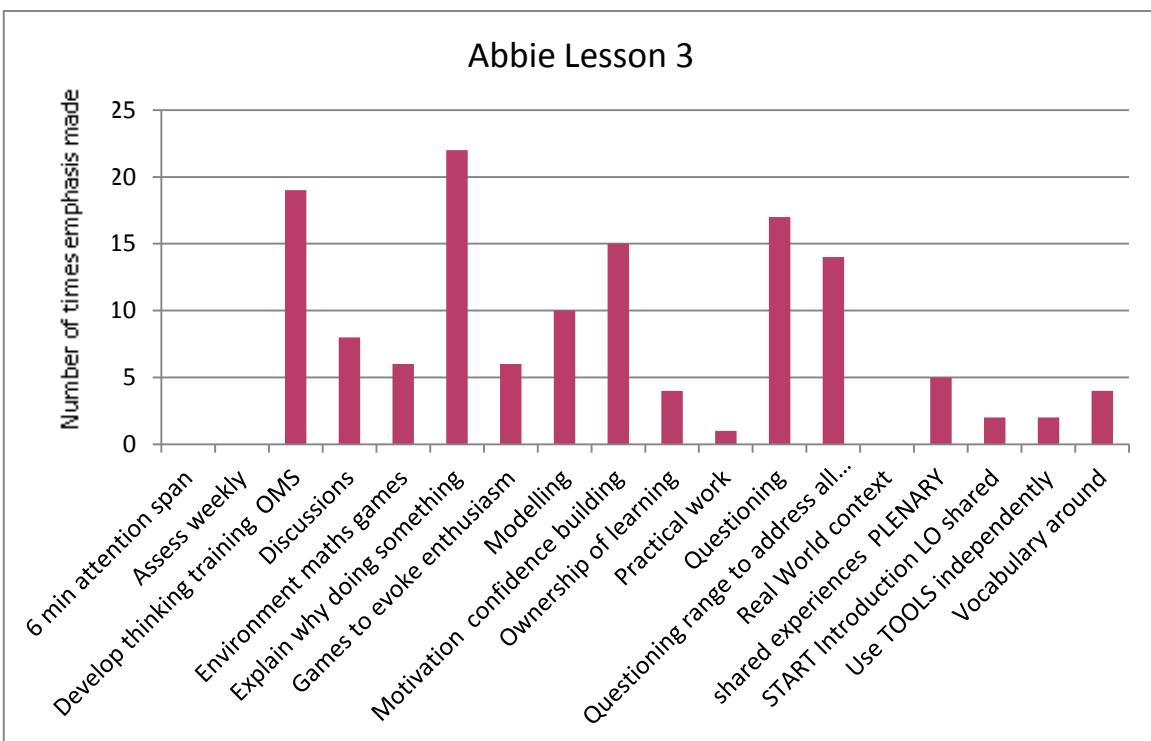


Figure 4.5: Frequency of codes Abbie L3

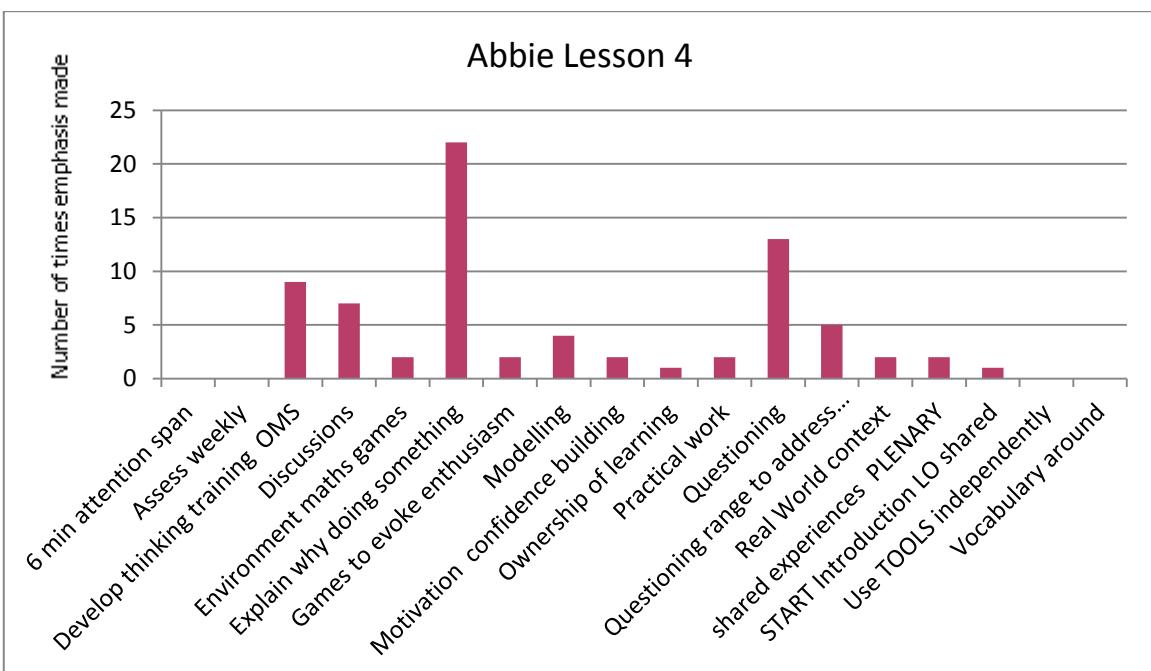


Figure 4.6: Frequency of codes Abbie L4

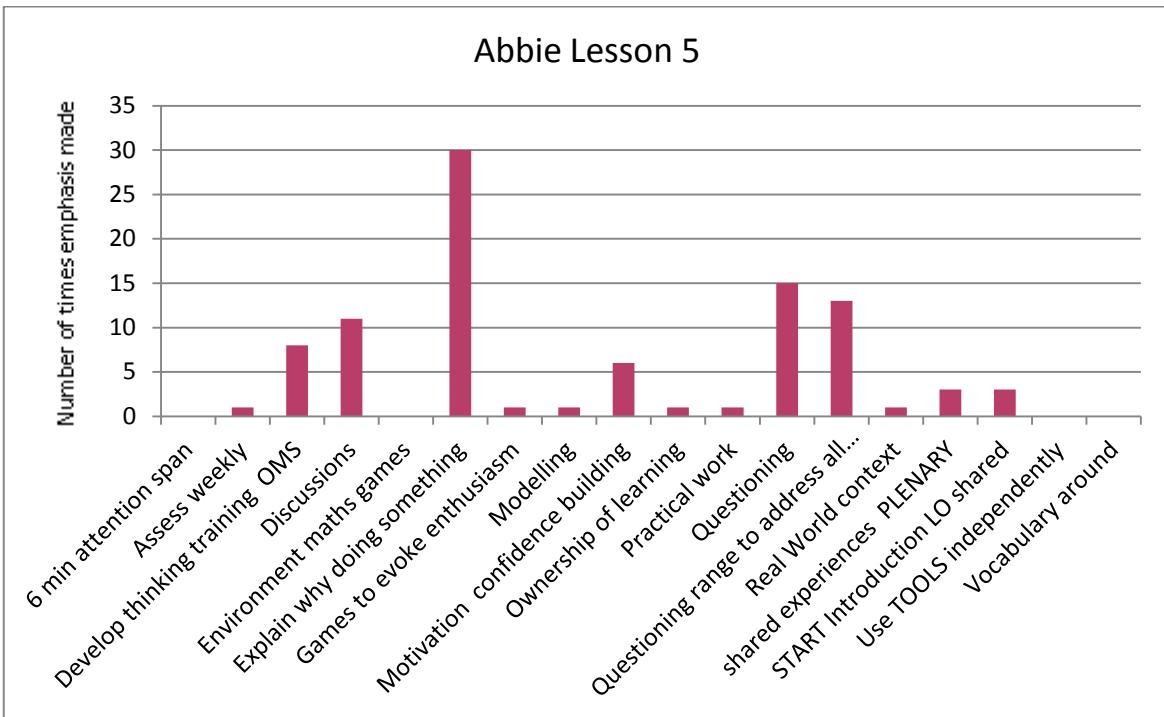


Figure 4.7: Frequency of codes Abbie L5

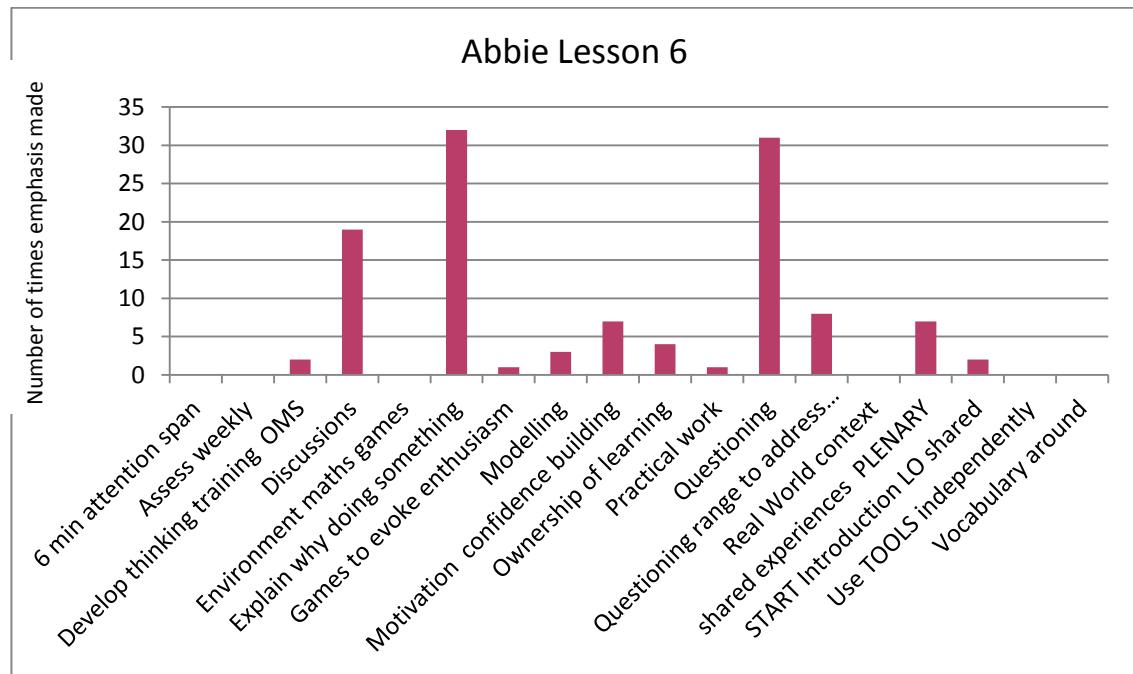


Figure 4.8: Frequency of codes Abbie L6

The data in figures 4.3 – 4.8 (six lessons), show clearly that several themes identified in Abbie's preliminary interview were observed regularly throughout her lessons in ways indicative of a set of classroom norms. She encourages her children to think during the OMS, she discusses, she expects her children to explain while doing something, she questions and so on. In sum, there are elements of strong resonance between elements of her espoused and enacted practice.

The following graphs (figures 4.9 – 4.14) represent the frequency of observed codes in Beth's six lessons:

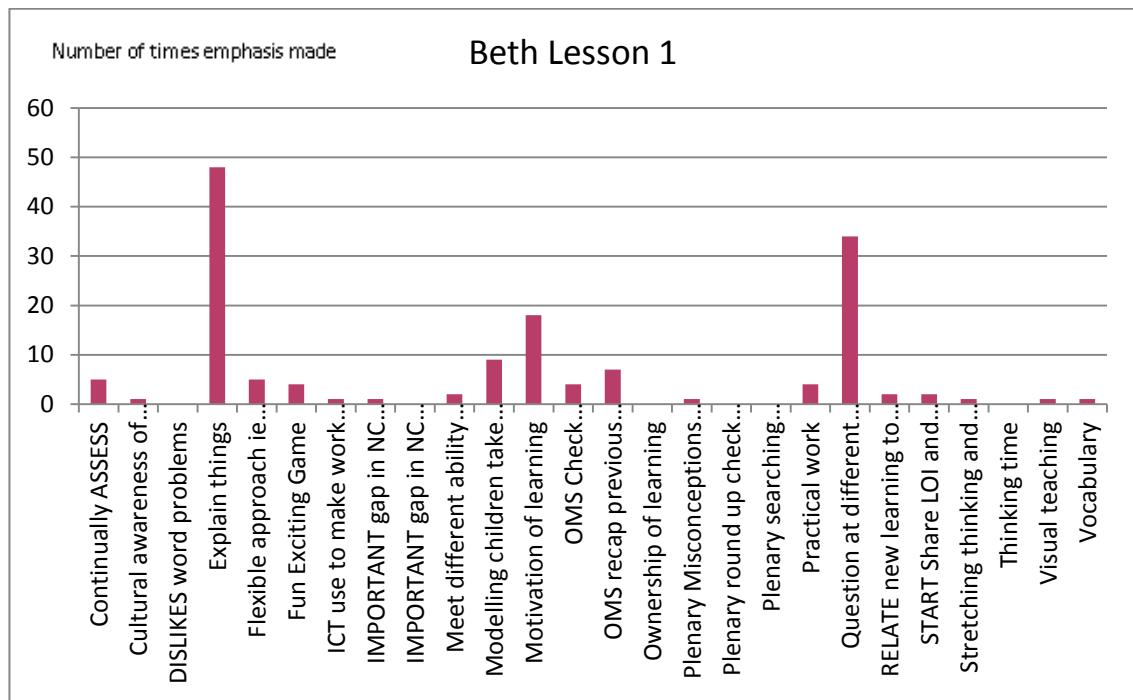


Figure 4.9: Frequency of codes Beth L1

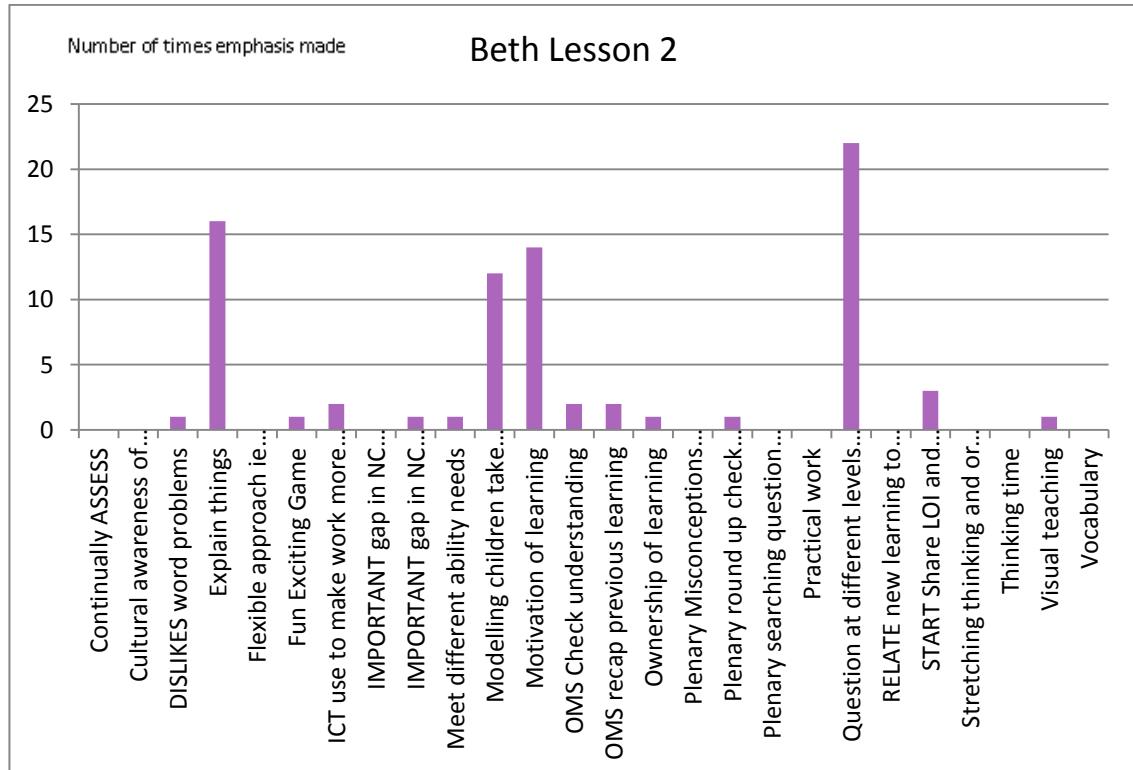


Figure 4.10: Frequency of codes Beth L2

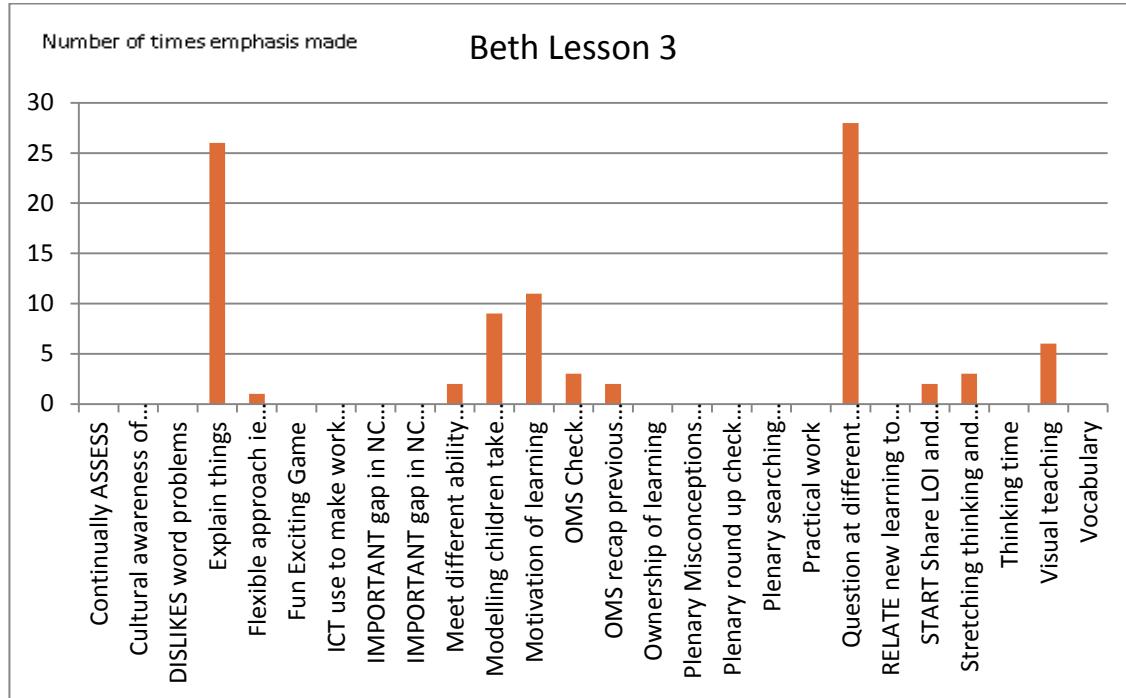


Figure 4.11: Frequency of codes Beth L3

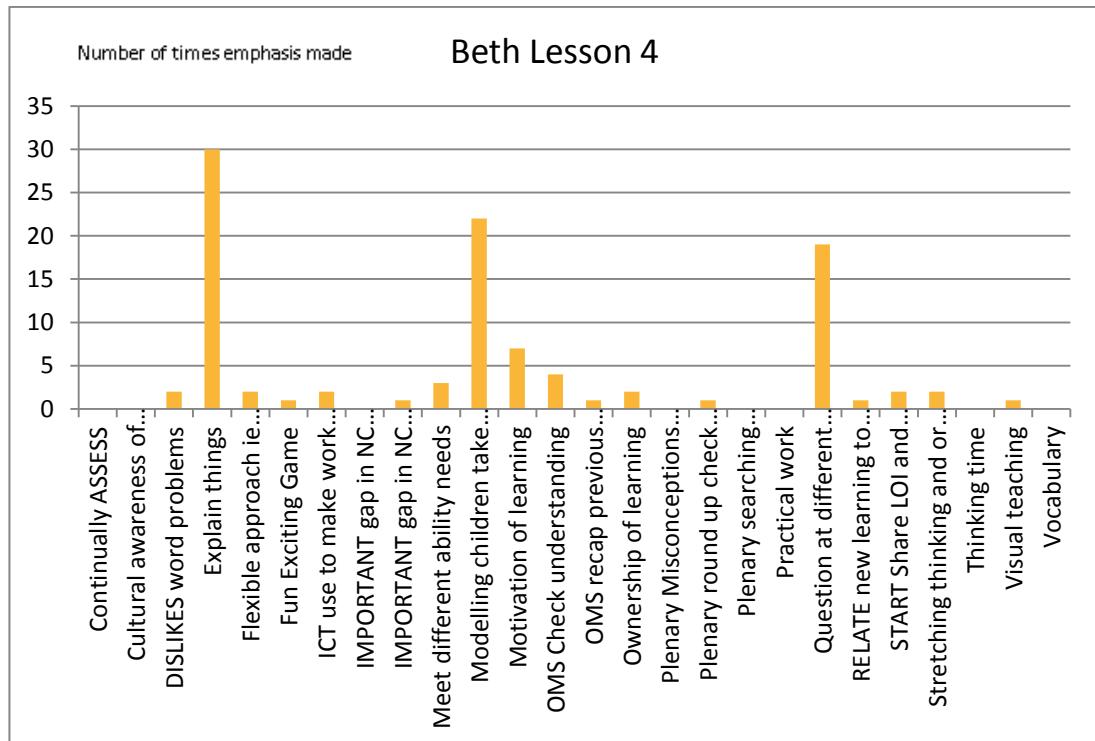


Figure 4.12: Frequency of codes Beth L4

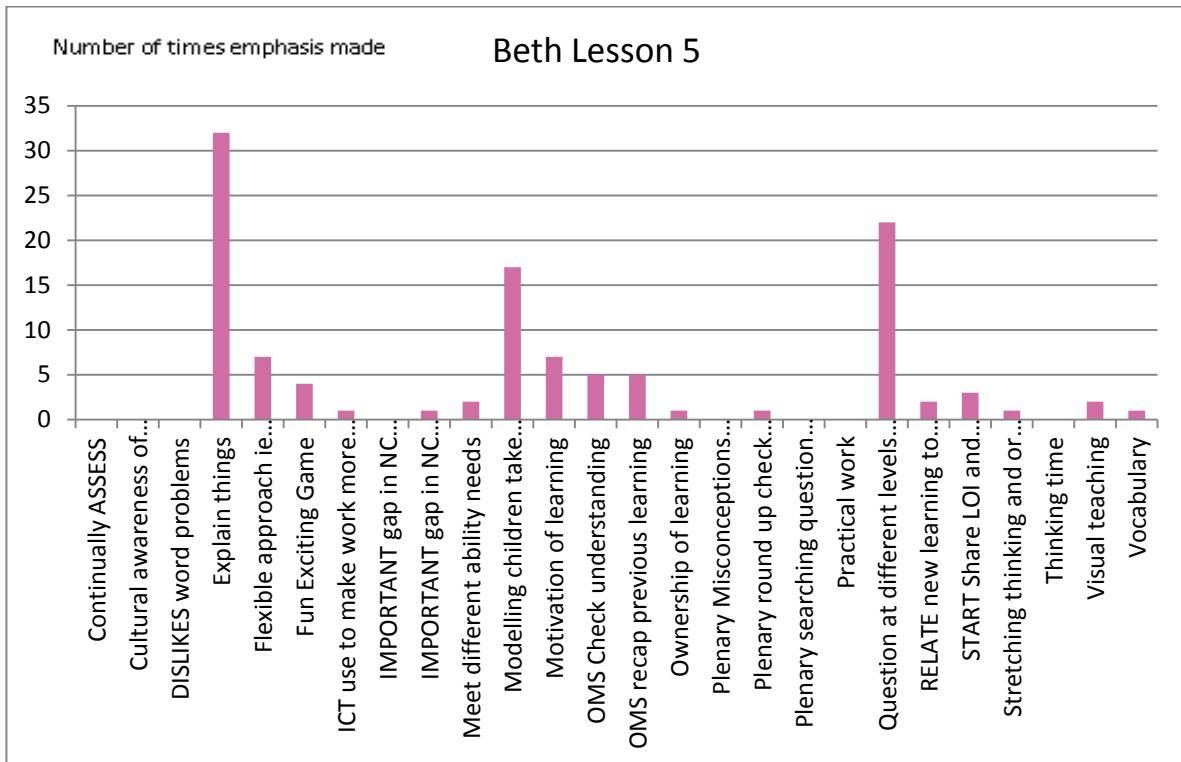


Figure 4.13: Frequency of codes Beth L5

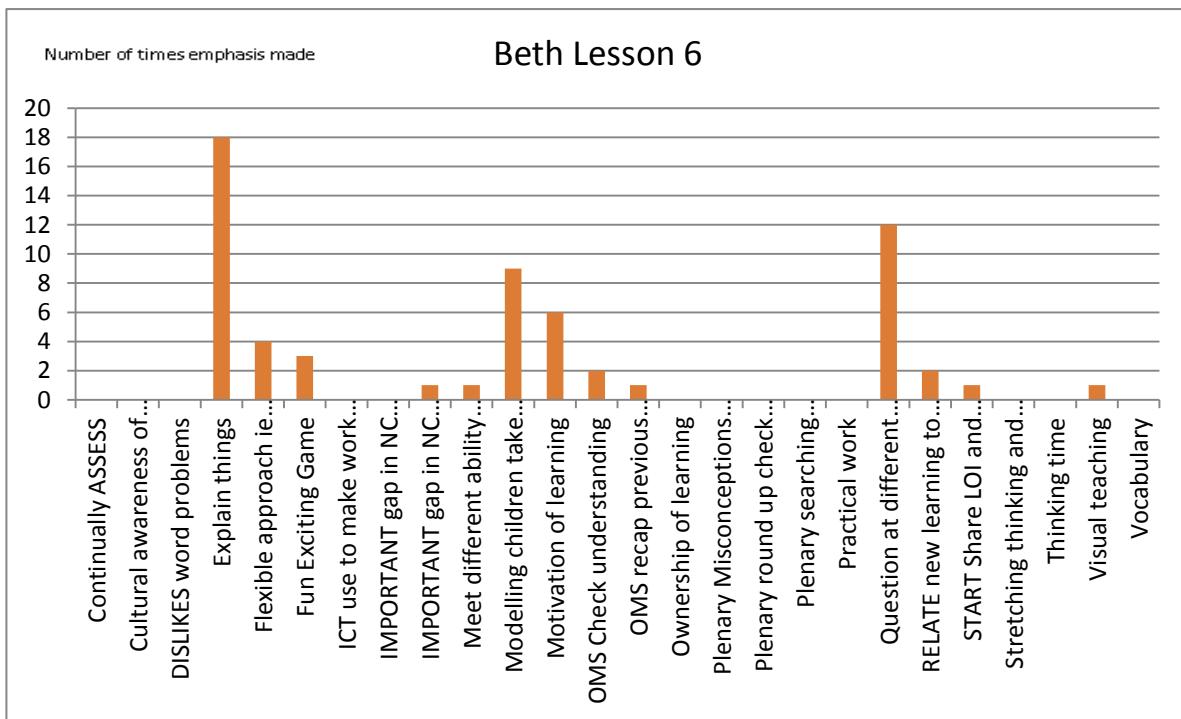


Figure 4.14: Frequency of codes Beth L6

The data in figures 4.9 – 4.14 show clearly that several themes identified in Beth's preliminary interview were observed regularly throughout her lessons in ways indicative of a set of classroom norms. She explains things, she models things, she motivates her children, she questions at different times and so on. In sum, there are elements of strong resonance between elements of her espoused and enacted practice.

Indeed, when the frequencies for all six lessons were combined, a clear sense of pattern emerged for each teacher. The data for these can be seen in the following bar charts (Figures 4.15 and 4.16 below).

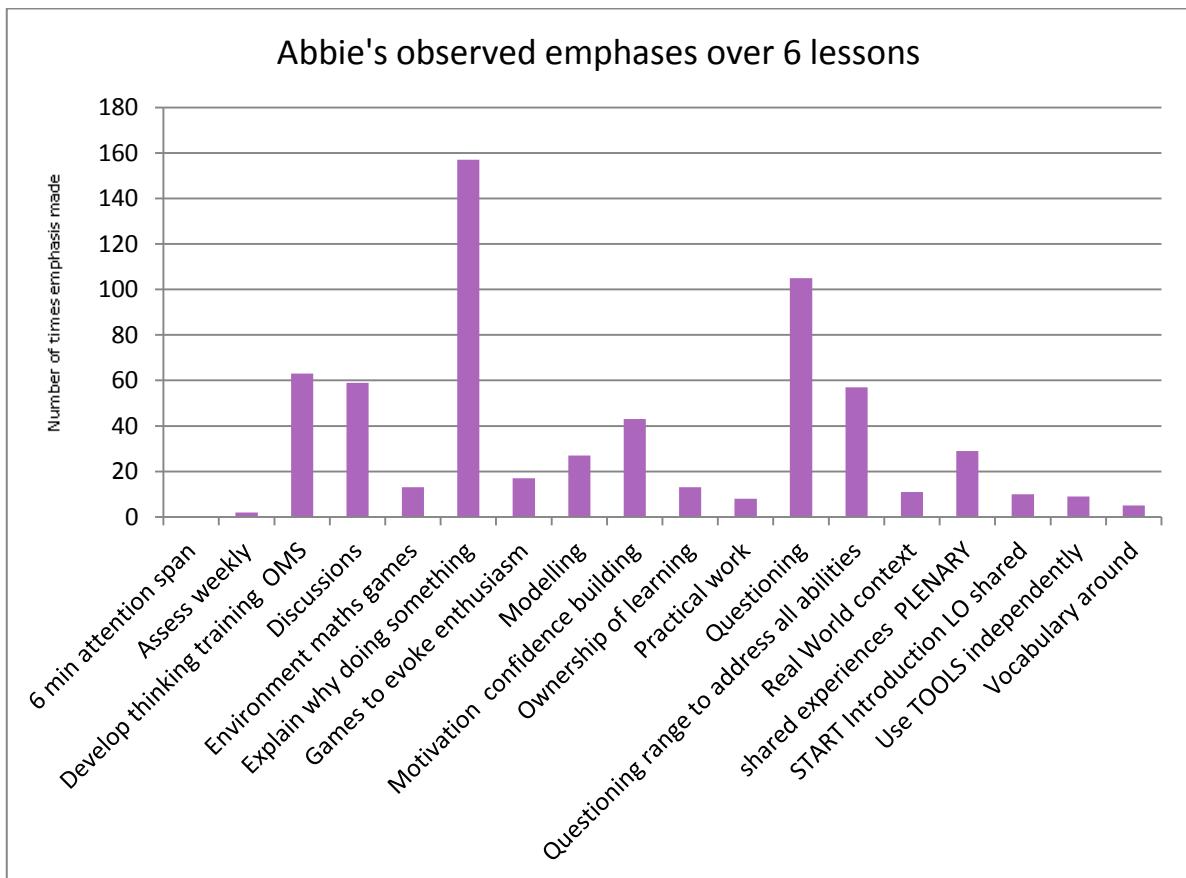


Figure 4.15: Abbie's observed emphasis coded over 6 lessons

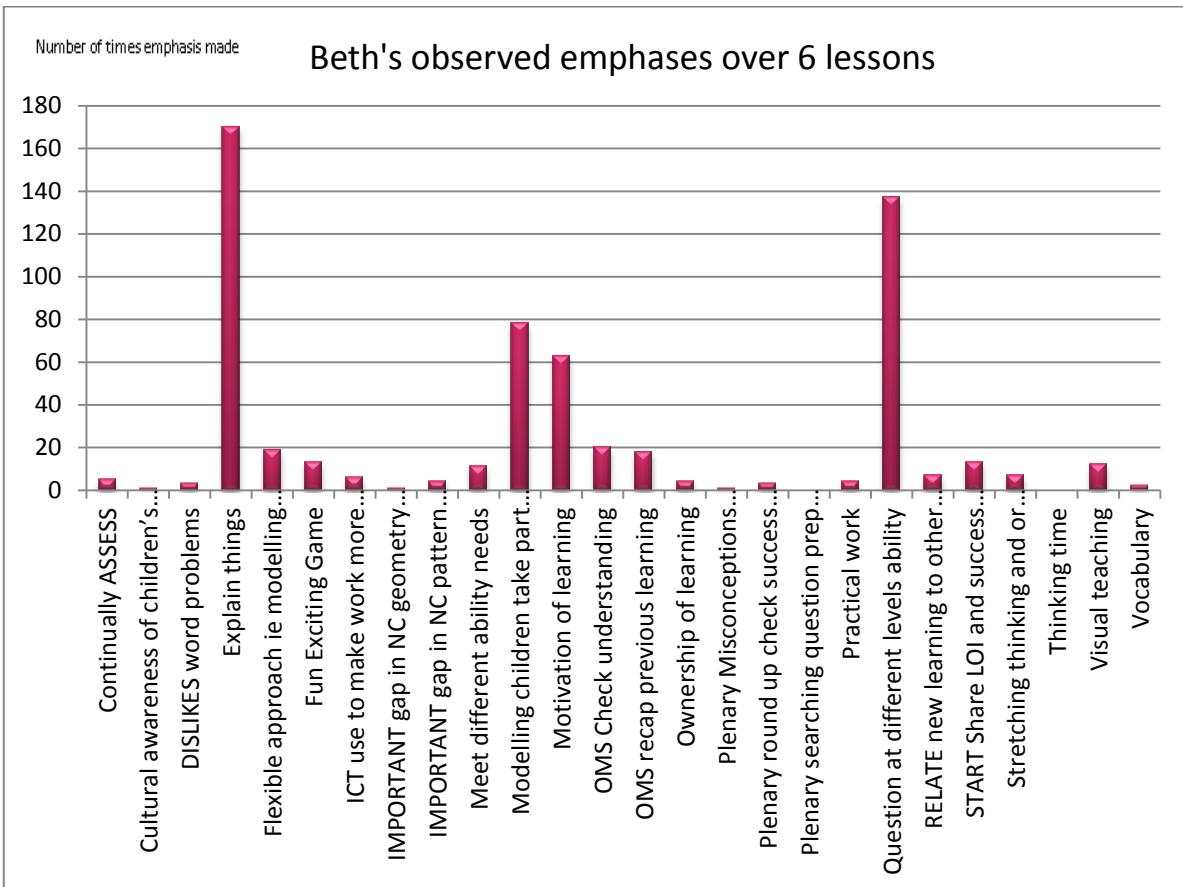


Figure 4.16: Beth's observed emphasis coded over 6 lessons

Of course, all the charts above show how one teacher's espoused beliefs, as reflected in the codes that emerged from the preliminary interviews, were matched in that same teacher's practice. That is, no attempt has been made to examine the extent to which one teacher's espoused codes may have been present in the other's observed practice. In the following, by way of assessing the robustness of both the codes themselves and my ability to recognise them, I analysed Beth's six lessons against Abbie's codes. I did it this way round because Abbie's interviews had identified fewer codes than Beth's and should, therefore, have presented a simpler and more straightforward task. The results of this process can be seen in figure 4.17 and show that the codes are robust and able to draw appropriate information from the data collected. The implication for the main study here is that analysis codes can be drawn from the initial interviews to enable an accurate and effective overview of an individual's practice.

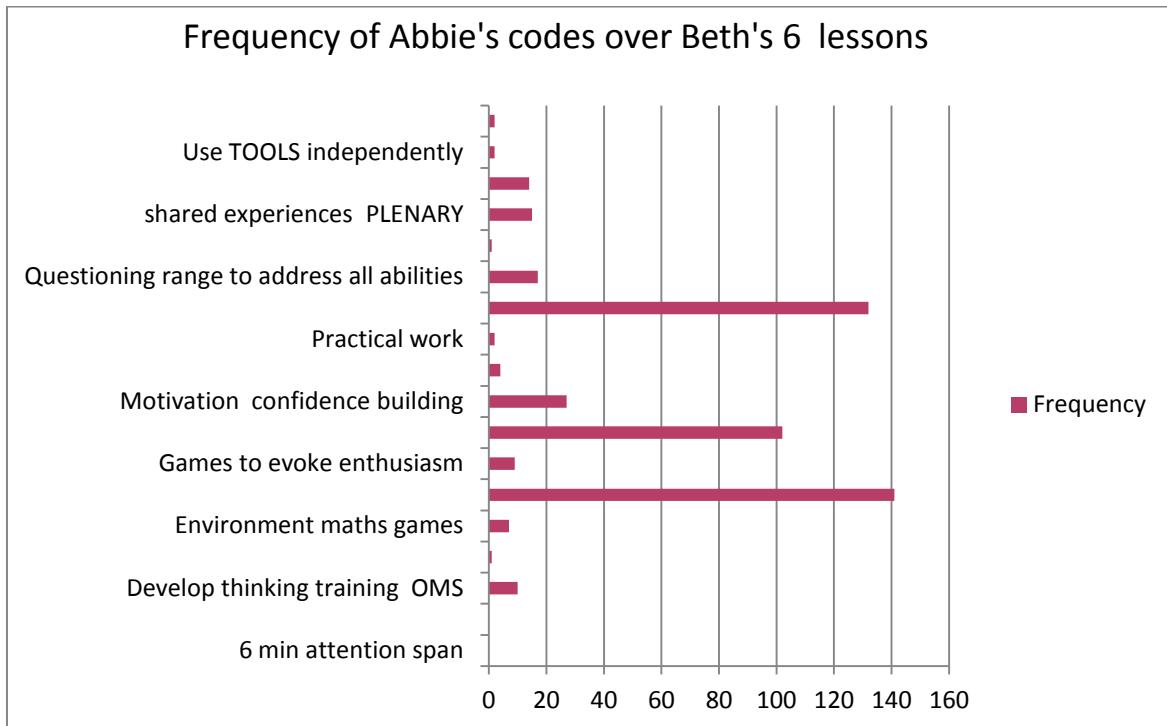


Figure 4.17: Beth's six lessons analysed through Abbie's coding scheme.

In conclusion, much was learnt in this initial phase. Essentially, the codes derived from the preliminary interviews proved effective in the development of coding schemes with which to analyse lesson observation data, and more importantly, provide the link between the teachers' espoused and enacted beliefs in the classroom. Significantly, by way of informing the second phase of the study, three key themes have emerged from this process of code development. The first is that the mathematics, its content and processes, has been privileged by the two teachers in different ways and that this privileging has permeated all aspects of the data for that teacher. Thus, the second phase will need to ensure that mathematics, and the way it is articulated by teachers, does not go unnoticed in either data capture or analysis. That is, any analysis of the WCI phases of a lesson will need to account for the mathematics-related emphases of the teachers involved. The second is that the two teachers highlighted very different aspects of their professional pedagogies. Any further examination of teachers' beliefs and practice will necessarily need to ensure that a teacher's pedagogical approaches are uncovered and explicated by subsequent analyses. The third is that the analyses have highlighted patterns of practice, derived from teachers' mathematical and pedagogical emphases that allude to classroom norms unique to the individual. Any subsequent work will need to ensure that its data capture and analysis processes will facilitate the identification of such important characteristics of the individual teacher. This last issue is not new in the mathematical educational literature. Yackel and Cobb (1996), for

example, discussed how mathematics teachers train children to respond in habitual ways that may privilege social behaviour, mathematical behaviour or both (Lerman, 2001). These themes, a teacher's mathematical intentions (MI), pedagogical approaches (PA) and classroom norms (CN) will be explored further in the main study although, by way of indicating how they play out in this first phase, I attempted to locate Abbie's codes against them. The results of this can be seen in table 4.6 and show that they all fall comfortably within them.

|                        |   |
|------------------------|---|
| Learning Outcomes      | 3. Develop (mathematical) thinking<br>10. Ownership of (mathematical) learning<br>17. Use TOOLS (prior knowledge) independently<br>18. Vocabulary (mathematical)  |
| Pedagogical Strategies | 19. attention span (attention to teacher's understanding about learning )<br>3. Discussion emphasised<br>4. Environment – games to motivate learning<br>5. Explain why doing something (justification)<br>6. Games to evoke enthusiasm<br>7. Modelling<br>8. Motivation confidence building<br>9. Ownership of learning<br>11. Practical work<br>12. Questioning<br>13. Differentiation - Questioning range to address all abilities<br>14. Real World context<br>15. shared experiences PLENARY/REVIEW<br>16. Structure- START Introduction LO shared<br>18. Vocabulary encouraged |
| Classroom Norms        | 20. Assess weekly<br>3. Develop thinking training OMS   |

Table 4.7: Abbie's data analysis codes – theme development

## 4.6 Discussion and implications for phase two of study

In the following I consider the above and its implications in respect of informing the development of phase two of the study. I do not return to my decision to abandon pre-determined analytical frameworks as I feel I have already discussed this in sufficient detail. I focus on discussing the issues emergent from the data driven analysis and how they will inform the second phase of the study.

#### **4.6.1 Initial Interviews**

Key issues emerged from the analyses of the preliminary interviews. Firstly, they alluded to a strong relationship between a teacher's background and his or her espoused and enacted beliefs. Indeed, Abbie's excitement as a learner of mathematics seemed to have a very different pedagogical impact from Beth's somewhat taciturn acceptance of the subject as a necessary evil. Consequently, any revised interview schedule will ensure that this aspect of colleagues' life histories will be addressed as fully as possible. Other issues relating to mathematics and its teaching have been discussed at some length above and are not discussed further here.

#### **4.6.2 WCI-related observations and SRIs**

The lesson observation data, including those derived from the SRIs, were extensively analysed in different ways, some of which have been rejected as inappropriate. The key issue to emerge was that when analysed against codes derived from the individual' preliminary interview, patterns, indicative of unique classroom norms emerged. Importantly, by way of warranting the procedures of the second phase, the six lessons observed for each of Abbie and Beth were randomly selected and indicated that fewer observations would probably suffice for future work.

The most significant outcome, derived from the qualitative analyses, was that although the teachers used the same words, they often meant very different things. For example Beth talked about explaining mathematical concepts, activities and resources to children, yet Abbie only spoke of children explaining to the rest of the class or to her in WCI phases. Discussion was also found to provide differences of opinion. For Beth this was a teacher led, essentially closed, and controlled activity, where she could steer and direct children to specific outcomes. For Abbie discussion was different. Discussion for her could be child led or teacher led, the most important difference was that children were involved and could take the lead. This was an interesting difference and one to which I propose to be alert in the main study. Other pedagogical approaches presented themselves differently in the teachers' descriptions and observed emphases. Modelling and demonstration were of particular interest and may be of particular interest in the study. Finally, as indicated earlier, different classroom norms emerged from the observation and SRI data which confirmed the importance of its inclusion in the main study.

The table that follows (table: 4.7), extends over three pages, highlight some of these key characteristics to emerge from this first phase.

| Similarities              |  | Notes to inform main study   |
|---------------------------|--|--|
| MI                        | Abbie and Beth   |  |
| Prior Knowledge           | Reactivated at the beginning and throughout the lesson   | Where is the mathematics emphasised in learning?   |
| PA                        | Abbie and Beth   |  |
| Enjoyment                 | Seen to emphasise a good attitude through the enjoyment of the subject or the resources  | Although both espoused enjoyment in mathematics, the utterances appeared to emphasise either to develop an enjoyment of the subject or the use of interesting resources.<br><br><a href="#">Need to probe more in main study</a>   |
| Discussion                | Discussion was emphasised  | Discussion was seen but in varying degrees. Child led or teacher led? <a href="#">Need to probe more in main study</a>   |
| Approach to learning      | Emphasis made on understanding their class' attention span and expectations of outcome   | Is this something all teachers attend related to belief: <a href="#">Need to probe more in main study</a>  |
| Demonstrating & Modelling | Demonstrating and modelling  | The data analysis appeared to suggest these were similar, however, there appeared to be differences in the observations of the emphasis e.g. was it demonstrating or modelling, what was the difference between the two approaches? <a href="#">Need to probe more in main study</a> |
| Vocabulary                | Vocabulary emphasised  | The observations revealed differences in when the vocabulary was emphasised – <a href="#">Need to probe more in main study</a>   |
| CN                        | Abbie and Beth   |  |
| Fun in maths              | emphasised enjoyment <i>of</i> mathematics and the enjoyment of <i>using</i> a wide range of resources – enjoyment of partaking? | <a href="#">Need to probe more in main study:</a> difference in these two emphases   |
| Attitude                  | Develops positive attitude towards mathematics   | <a href="#">Need to probe more in main study:</a> in what ways are positive attitudes developed?   |

|                        |  |   |  |
|------------------------|--|---|--|
|                        |  |   |  |
| Differences            |  |   |  |
| MI                     | Abbie  | Beth  | Need to probe more in main study   |
| Prior Knowledge        | Reactivated throughout the lesson  | Reactivated at the beginning of each lesson   | Pattern of practice was revealed in the way PK was activated.  |
| Connections            | explicit connections were made between mathematical topics and real-life experiences   | Beth made implicit connections between topics and context   | Will this be relevant in main study? Askew et al (1997) believe only effective teachers make explicit connections.   |
| Mathematical reasoning | Abbie continuously provided questions and opportunities to think about concepts through whole class discussion   | Beth asked conceptual questions to the whole class but expected individuals to think quickly and respond – little observed paired thinking time provided.   | Beth used these instances to assess individuals. Teachers have very specific purposes for their emphasis – needs to be deconstructed with other teachers in main study. Is this an individual's preference?                                    |
| PA                     | Abbie  | Beth  |  |
| Questioning            | A range of styles of questions asked: open short closed and strings of closed. Probing questions were deliberately pursued with some individuals to assess understanding of concept. | A range of questions asked - focussed on specifically directed questions, often strings of closed questions. Very purposeful and directed often to individuals (differentiated to levels of ability). | This category is well researched, it will be interesting to see if other teachers take very purposeful approaches. Time provided for thinking and discussing ideas drawn from the questions. Or: Quick firing, very deliberate and structured. |
| Discussion             | Whole class discussion was observed as a consistent approach in lessons observed. Pace of discussion varied from short and quick to fairly long. Teacher and child led.              | Discussion was teacher led through initial questions and individuals answers in response.   | Are there further different interpretations of what discussion is?   |

|                                   |  |   |  |
|-----------------------------------|--|---|--|
| Modelling<br>And/or Demonstration | Abbie modelled games and worked through examples on board with child input.                | Beth prompted individual's participation in worked examples | Are Demonstration and modelling interpreted differently and/or expectations of children's involvement  |
| Fun and enjoyment                 | Focussed through the use of task to present the mathematics.                               |   | Probe through observation and SRI  |
| CN                                |  |   |  |
| Flexible                          | Pace, discussion and direction, sometimes teacher led sometimes child lead to some degree. |   | What is Pace?<br><b>Need to probe more in main study</b>   |
| Structured                        |  | Strong structure to direction and purpose of WCI.           | How important is this to the teacher? And how does it influence the emphasis of teaching mathematics?<br><b>Need to probe more in main study</b> |
| Attitude                          |  | Concerns voiced about the low-baseline of entry in context  | Does this influence the focus of mathematical learning? <b>Need to probe more in main study</b>  |

Table 4.8: Key Characteristics emerged from data (similarities/differences)

As indicated above, three themes emerged that appeared appropriate for structuring data analysis. These were a teacher's mathematical intentions (MI), pedagogical approaches (PA) and classroom norms (CN). All evidence indicates that these will facilitate a deep and meaningful analysis, not least because they reflected very well teachers' emphasis as observed and highlighted in SRI discussions.

In sum, the outcome of this first phase is that the research questions are appropriate and amenable to the data collection approaches used. Despite early difficulties pertaining to the use of pre-determined frameworks, the analytical approaches adopted have proved effective and have yielded the sorts of insights for which I had hoped. Consequently, the second phase will involve four new cases, similar approaches to data collection, although the six lessons will be reduced to three, and adaptations of the revised approaches to analysis. In so doing, I hope to obtain rich data that will be analysed in such depth that a thorough and appropriately novel understanding of how teachers construe the WCI phases of their lessons will emerge.

## **Chapter 5 Presentation of Case Studies: phase 2**

### **Structure of the case study**

The four case studies presented in this and the following three chapters are in two parts in order to highlight particular characteristics of each teacher's espoused beliefs and attitudes, and secondly, the enacted teaching practices alongside their conceptions. The four teachers are named here as: Caz, Fiona, Gary and Ellie.

### **Part one: Background: beliefs, attitudes and influences on teaching**

This first section provides a summary of the semi-structured interview at the start of the second phase of the study, and offers background information for each teacher and the context in which that teacher works. It is presented through three categories which detail elements of beliefs, attitudes and preferences towards the teaching of a whole class phase of mathematics lessons;

School context:

- Details of the school situation in which the teacher taught during the time of filming

Belief Formation towards mathematics as a subject and as a teacher:

- Personal experiences as a child
- Personal experiences as a trainee teacher
- Personal experiences as a teacher and perceived expectations, limitations and opportunities. This may include curriculum framework, the contextual influence of colleagues, managers, advisors, parents, children, resources and buildings.

Belief Manifestation in practice:

- Pedagogical approaches to mathematics teaching and/or teaching in general
- Whole class interactive phases
- What a typical mathematics lesson might be

As previously mentioned in chapter three, a sample of initial interview transcripts can be found in appendices 3.3.

### **Part two: Mathematics teaching in practice**

This second section presents a summary of the two or three lessons observed and then later discussed through stimulated recall interviews (SRI) to allow reflection. The presentation of this section has been separated into three categories:

- mathematical Intent (MI)
- pedagogical approaches used (PA)
- classroom norms: behavioural patterns (CN)

The three categories represent the three most significant characteristics to emerge from the data that appropriately describe WCI phases of lessons. Mathematical Intent (MI) which reflects the teacher's focus on the learning aims in the subject, which has already been discussed in the literature review. The second are the Pedagogical Approaches (PA), which also reflect the literature already reviewed, and much of the professional documentation. Finally, the third: Classroom Norms (CN) emerged from the data in the first phase study which identified a regular pattern to the way in which the teachers conducted their WCI phases of mathematics lessons. Each individual was seen to behave and offer consistent perceptions for that behaviour thus establishing a *classroom norm* as described by Yackel & Cobb, (1996) and Chazan et al. (2012). Utterances made by the teacher are presented in all cases in *italics*.

Appendix 5.1 provides an example of the first level analysis results through a table representing lesson narrative matched to SRI utterances. Appendix 5.2 provides an example of how the categories were used matched to the teacher's utterances in SRIs and the mathematical learning observed.

## 5.1 The Case Study of Caz

### 5.1.1 Background: beliefs, attitudes and influences on teaching

This first section provides a summary of the semi-structured interview at the start of the second phase of the study, and offers background information for teacher Caz and the context in which she works. It is presented through three categories which detail elements of her beliefs, attitudes and preferences towards the teaching of a whole class phase of mathematics lessons.

#### 5.1.1.1 School Context

Caz was a year four teacher in a one form entry first school in a suburb of a small county town. She had been the Numeracy coordinator for three years and was gathering evidence to apply for an Advanced Skilled Teacher in mathematics in her local authority. Her head teacher had been at the school one year and had been working closely with her staff on the development of new pedagogical approaches which Caz found to be very exciting.

She had been teaching seven years. Her first year was teaching a reception class and, although she believed she had benefitted from her Early Years studies she preferred working with her current year group, year 4, which is the final year group of this First School.

Caz described herself as a child who not only *always enjoyed maths* but also had a *natural talent* for it. She recalled several key aspects in how she believed she differed from her peers. For example she remembered assuming that everyone else was enjoying mathematics just as she was, and could not understand why mathematics *wasn't so obvious to everybody*. She found all aspects of mathematics *quite easy* although she became increasingly aware of how different she was from her peers when she first experienced ability streaming in middle school. It was not until she came to teach that she became aware of the extent of her earlier naivety.

She attributes much of her enjoyment of the subject and school in general to having *loads of good teachers throughout her middle school experience*. *She remembered one in particular because she also shared a love of maths*. In addition, she spoke much of her enjoyment in exploring mathematics at home with her father and younger brother, believing that the sort of games found on, the Nintendo DS today *with puzzles and games and things* were similar to the things *we used to do with pencil and paper together* at home. She continued to enjoy playing with, logic puzzles, and remains keen to engage children in interesting mathematics,

like the exploration of the work of Fibonacci that she had experienced as a child with her family.

Beyond compulsory schooling Caz completed A' level mathematics, a psychology degree, in which she studied childhood development, and an advanced Early Years certificate with a local School Centred Initial Teacher Training (SCITT). She believed her childhood development psychology course was an essential element of her understanding of what it is to be a professional teacher in general and in mathematics in particular.

### **5.1.1.2 Belief Formation towards mathematics as a subject and as a teacher**

In respect of her role as a teacher, Caz believed that the creative curriculum had substantially transformed children's attitude to mathematics in school. Previously, lower ability children would describe how others were *so much better at mathematics*, with consequent *low esteem*. She and her colleagues had noticed a significant change in positive attitude towards learning in the children as a result. She believed this was partly due to increased emphasis on class discussion throughout her lessons and created not only more confident children, but also a more *relaxed attitude* amongst them. Caz commented *I think if you can get it so the children feel that it's okay to put their hand up and say, I don't understand, and it's okay that they don't know it (all) yet. Then that can rub off on (everyone)*.

Caz considered The Primary National strategy to be a useful resource for less confident teachers, but felt that many such colleagues felt they could not adapt or move from the framework. However she acknowledged that such adaptation was difficult for the less confident, just as she *would find it so in other subjects*. That said she believed she had sufficient mathematical confidence to work autonomously *with it, around it, and through it quite flexibly, with or without the units of work suggested by the new framework*. She added *I do come away from that (new framework units)... I think the teacher is the expert so if you feel this is what this class need, just because the Framework doesn't say year four do this in term two block C, doesn't mean you shouldn't do it.*

### **5.1.1.3 Belief Manifestation in practice**

This section of the preliminary interview provided insights into how Caz perceived her own teaching of the subject through her pedagogical approaches in general, but in mathematics in particular and how she managed WCIT phases as well as what a typical mathematics lesson might look like.

Caz reported that she did not believe children who found mathematics problematic to have difficulties with particular topics; she believed that it was perhaps related to whether a teacher taught mathematics in a practical way or not, e.g. practical activities, where mathematics was disguised in ‘pirate week’. The children went on a treasure hunt and had not realised they were *doing maths*. She feels that it is when children are sat down with a pencil and paper *that's when they struggle*, because they have had little or no practical input.

Caz declared that the only person apart from her father that had an influence on her mathematically was Fibonacci. She said she used *him* in some of her teaching e.g. his work on the importance of zero. She talked about encouraging her year four class to work without using zero so that they realised how important that digit is. She felt that there were many different investigations that could be explored using Fibonacci's ideas, e.g. in nature. She talked about how good it was when children got interested in such things, believing that children who were interested in history, for example, might be inspired to research more about Fibonacci.

When asked what she hoped the children to experience in mathematics lessons with her, she said she wanted them to find mathematics as a *playful experience* as she did. She wanted them to go away and play with numbers just as she remembered herself doing as a child. She wanted them to see numbers as something that has *infinite possibilities*, enjoying a *magic of numbers*. She believed that when children realise those things, they too can become *hooked* on it.

The ideas described above also resonated with what she reported to share personally with her class e.g. architecture and ancient building structures such as the pyramids as well as more modern buildings like St. Pancras station renovation in London. She talked about the roof structure and how inspired she was by it when she first saw it. Although it did not influence her teaching directly, she enjoyed sharing her enthusiasm for these things. Moreover she believed this an important part of her role in the development of mathematical conceptual knowledge in children. Knowing that her job is *to lay the foundations of what the children will be meeting in year 6 and year 8* and acknowledges that if she does not teach these elements correctly they will need to be undone before the children can continue their development.

Caz described a typical lesson structure for mathematics was usually in three or more parts. She typically began with an oral, mental starter that was pacey and interactive with as many children involved as possible, often through a game. She always looked at the learning with the children at the beginning of a lesson through the sharing of *learning objectives*, but confessed that sometimes it was more interesting and appropriate to *go off track* and follow the interest of the class, *it was still relevant to the children's learning.*

#### 5.1.1.4 Summary

To summarise Caz's personal orientation towards mathematics she emphasised the following points:

- she had a natural talent for the subject
- enjoyed playing with numbers and logic puzzles
- she was strongly influenced by her father's enjoyment in mathematics and the sciences
- for a long time she did not understand why mathematics was difficult for others
- found mathematics playful rather than hard work or laborious
- she believed her EYs psychology degree and training had helped her enormously in her professional identity and understanding of theory and practice.
- took a confident and flexible approach to her planning purposeful and meaningful mathematics
- was aware of how her change of approach had improved children's motivation and success in the subject.

Finally embedded in all the above were a number of pedagogical practices presented as elements of her day to day working, those included:

- **Modelling:** Caz worked through examples on the board regularly, as if she was a child, to *show mistakes that children make and to say aloud* what she believed *children might think as they worked through their examples independently*. She also thought that it was important to model the use of resources to support mathematical thinking and understanding.
- **Making Connections:** Caz made explicit links between different stages of learning mathematics to support children's thinking and understanding of how concepts develop. She believed it was important to *expose children to more complex ideas* before they are explicitly taught how to work with them e.g. *show that hundredths are smaller than tenths when learning how to read, recall and manipulate tenths.*
- **Questioning:** Caz believed that a range of questions should be planned, asked and developed with the children in all WCI. She emphasised that different lessons would demand different levels and quantity of questions, and a different use of questioning at different times. E.g. to differentiate between children and to assess. However questioning was an essential part of her role as a teacher.

- **Explaining:** Caz believed explaining was the core of any teacher's practice through different strategies, e.g. explaining how to do or record something. Therefore it not only covered mathematical subject knowledge, but also key skills e.g. using *talking partners to support each other in discussion* to develop mathematical reasoning, as well as *good speaking and listening skills*.
- **Involving children in their learning:** Caz believed she used a wide range of equipment and resources, including ICT, to *involve children in developing their thinking skills*. She *used the children's ideas and interests* to develop mathematical thinking and learning.
- **Flexibility:** Caz talked confidently about how she might *change and redirect a lesson*, not necessarily conforming to conventional structures of lessons. E.g. with the introduction of the creative curriculum.

### 5.1.2 Overview of Mathematics Practice

This second section presents a summary of the three lessons observed and then later discussed through stimulated recall interviews (SRI) to allow reflection (a sample of coded transcript can be found in appendix 5.1). The presentation of this section has been separated into three categories:

- **mathematical intention**
- **pedagogical approaches used**
- **classroom norms (behavioural approaches)**.

Each category presents the data that characterise the enacted practice observed in the three lessons. Each item has been supported by examples of events consistently observed or comments consistently made or emphasised by Caz in the SRI providing evidence of the way in which she conceptualises her practice. Comments made by Caz are represented here in *italics*.

#### 5.1.2.1 Mathematical Intent

**Prior knowledge** was consistently observed to refer to the children's previous lessons but also Caz talked about what the children would have learnt, or worked on in the previous year. She displayed a deep and knowledgeable understanding of the way in which mathematical concepts are taught in school and how they progress. For example, reference was made to a previous history lesson on the Egyptian water alarm clock, and why telling the time was important then, e.g. to go to *work in the fields*. She also related time to the children's 'life'. She asked the children *who gets told at home just 10 more minutes! or who asks to watch television for 10 more minutes?* which the children agreed they had. Caz related this knowledge to the significance of what passing of time meant to different people which led to a class discussion on what passing of time might mean to each of them. She said

*I knew each child took the question and made it their own and the learning then becomes, well for Ryan it becomes football, for Jessie it becomes about dancing, but she believed if the children relate this knowledge to mathematics they begin to see the connections between prior and new knowledge.*

Caz often referred to previous learning and encouraged children to think back to what they had already covered, *I am always trying to relate it (new knowledge) back to what they know, they already know how number lines work they already know about the 2x table*, she said referring to the example we were discussing, *I want them to see patterns in numbers, perhaps pointing out patterns and getting them to relate what they know about the number system and number lines.*

**Explicit Connections:** There were several examples of Caz making explicit connections between mathematical concepts in the observed lessons which manifested in different ways. For example, she asked the children to visualise a numberline when recalling numbers, she will hold a counting stick horizontally at first, then will turn the stick through 90° vertically and refer to it as reading a scale. Caz commented many times that she believed it important for her and children to make connections in whole class interaction (WCI), particularly in the case of the use of the numberline. She said that although it was a local authority directive she believed lines to be very useful to model the number system. She said it *helped children read scales...like on a thermometer and bar graphs, particularly when the scale on the 'Y' axis does not represent one unit*. Caz recognised that children can develop misconceptions in reading scales. She said how conscious she was of the importance of the first introduction to a new concept as it will affect future understanding. A *common mistake children make is assuming each line up the Y axis is one, so I do not always count in ones on the counting stick. We will count in fives say, I tell them they always have to check and refer back to 'just like we count on the counting stick', to remind them of that visual image we have used together in the past.*

Caz made connections between parts of the number system e.g. when counting up in tenths. She directly related this to *place value base 10*, by explicitly showing the children that 1-10 is similar to 0.1 – 1.00. Another example was when she drew a numberline on the board to represent 0 – 1 and placed nine marks between and wrote in 0.2 at the appropriate place. She then drew in jumps or leaps as the figure (5.1) below shows:

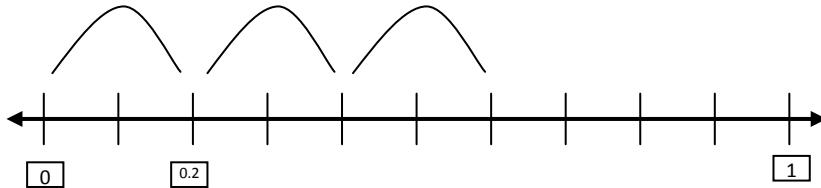


Figure 5.1: Number line example

Caz asked the class what this diagram reminded them of as she said she wanted them to see how it was just like counting up in twos in the two times table. When they did not respond to her question she said *after 0.2 (when counting up in 2 tenths) what comes next?* Although she explained it was not in her plan to draw the diagram, she believed she needed to respond to the children's needs and scaffold the idea. The children had already demonstrated that they could count up and down in tenths and so she wanted to *take them a little further on and make that connection for themselves.* Caz would often draw a numberline to remind, explain or instruct the children when discussing a concept such as this. She said *I think it's about bringing maths together.* Although it could be argued that Caz was consistently 'telling' children what to do and in what way to connect ideas, these were more often what happened in the moment, rather than a planned activity.

When Caz introduced a new concept, she explicitly mentioned the *bigger picture*, in other words, made explicit connections where the new learning fitted within other elements of mathematics. Caz stated that she was aware that *in year four we're working towards decimal numbers. I think once children have got place value (with) three digits, they can understand four digits and further so decimals to me just follow the same rule. To me they're obvious ...sometimes I wonder why we don't do it sooner, because we do money... I sometimes think if you introduce it much younger, it would be much more natural to them.* She concluded *it's just about applying rules to numbers they can work with - to numbers they haven't been used to working with, and using it in that different context.*

Caz indicated that she would often 'tweak' the mathematics curriculum she presented as she wanted to *help the children see the bigger picture.* It was particularly important for boys she thought, as *boys need to see the bigger picture in terms of learning, some girls too,* such as one lesson observed on time and reading clocks. She taught alongside teaching time why clocks are round, referring to the ancient Greeks and Romans *because we used to use sun dials to tell the passing of time* and measured rotation round the sun. She also explained that

she had taught the children how the Ancient Egyptians used a water alarm clock which she said fascinated them.

**Proficient recall of facts.** Caz emphasised children's pace of recall of numbers through chanting in unison at the beginning of a lesson (OMS). She believed it helped children to remember the factual elements of the number system, by increasing pace and using different actions or gestures it will support children's memory of facts. Caz believed that when children are learning something new they *put a lot of time into thinking about it...then they can do it*. She also believed that once children can do something

*they are putting less thought into it each time they do it so I want them to get it quicker because then I think they are thinking quicker about it. I think they got to the stage where they weren't thinking about it, they were just repeating it.*

She said she wants

*them to challenge themselves to do it quicker. And the quicker they can do this the quicker they can work with decimal numbers. The more that will help them when they come to do calculations of decimal numbers and things like that.*

**Mathematical thinking, reasoning and argumentation.** Thinking mathematically was a consistent emphasis in all observations of lessons. Caz explicitly encouraged children to 'argue' with her if they were confused or disagreed with anything she had said. Caz believed that critical thinking is an important aspect of children's learning to question and justify their ideas in mathematics. Indeed such an incident occurred in a lesson on fractions. Caz had been following Tom's line of explanation and had not spotted what another child had seen (see figure 5.2 below). Tom said that if there are two cake bars and six people represented, each person will have one piece each of each bar, therefore have one sixth of one and one sixth of the other each having two sixths altogether. Chloe pointed out that it would be two twelfths not two sixths of the whole. This created interesting discussion for the class, which Caz was very pleased with.

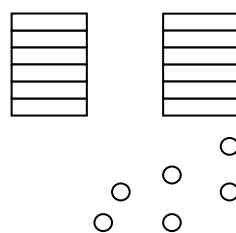


Figure 5.2: Cake slice fractions

Another example was where the class found it difficult to partition 4.5. Several responded to her question but gave the wrong answer, she consequently explained the position of the digits again, then asked the class whether it was because of the decimal point in the two digit number they had found difficult or something else. She said, *You know you can argue back to me... if I have got it wrong.* The class responded with questions about the difficulties they had illustrating that this approach was perhaps a *classroom norm*, Caz encouraged questioning and enquiry in her whole class phase of interaction.

**Real-life relationships** were also a consistent approach Caz was seen to emphasise mathematical thinking. For example she asked them 'Who has ever said... 'I can't wait?' She talked about the irregularities of people's referral to the passing of time. She also gave children opportunities to identify aspects of their interests in mathematics, e.g. What can you do in one minute? Score a goal, a series of dance steps; swim a length of the pool etc. encouraging children to make the connections explicitly between mathematics and their own familiar real-life context. Then gave them time to think and talk about it with their friends and teacher.

**Correct use of technical vocabulary and language.** Caz was seen to use correct technical mathematical language and vocabulary in all her observed lessons, she also talked knowledgeably in interviews. She recognised that some children needed to be supported explicitly when teaching new or unfamiliar words, she took time and explicit actions, e.g. ask children what words meant, what they looked like (structure) and what they applied to. She was seen to regularly react to the children's needs happening *in the moment* rather than just an explicit plan of progression in a typical lesson.

**Conceptual understanding:** Caz used and recognised different types of questions to develop conceptual understanding of mathematics. She questioned the children to reactivate prior knowledge *getting the children to think about what they already know.* She used questions to assess children in whole class interaction to inform her when to progress onto the 'next step' in the lesson. Although she thought she often went too quickly for some of the children, she was very clear that she *planned work at the higher level and then bring that down.* She believed she should have high expectations of the children's engagement, but also what they were capable of doing in a single lesson. Often *the children will continue the*

*session after lunch*, demonstrating that she was flexible in her teaching and planning to meet the needs of the class wherever possible.

To summarise this section, Caz demonstrated a great depth of knowledge and understanding through an autonomous approach to mathematics teaching and learning. She drew on her training and beliefs about mathematics as an enjoyable and interesting subject to learn. She was aware of how children can misinterpret mathematical concepts if they are not given as many opportunities to make connections for themselves through a range of activities, tasks and context.

### **5.1.2.2 Pedagogical Approaches used**

Caz emphasised her pedagogical approaches in her initial interview, however, many more were revealed through the observation of her lessons. This section is presented through the themes drawn from the individual case data coding.

**Discussion:** Paired talking was a consistent emphasis in all Caz's lessons, believing it is a most effective strategy in teaching children. She said *when I ask a question, it gives them the opportunity to talk to their partner about it. So for the less able children when I'm asking a more advanced question they've got someone to talk it back to, so they can still offer an answer. They can still feel like they're joining in. ...if I'm asking the less able a question then the more able have got the opportunity to help them and articulate what they know about maths, developing the language that they will be learning at a deeper level.* She used both open and closed questions for children to discuss in their pairs, but had a strong rationale for why she did this. She said this type of strategy *could result in a lot of (children's) dialogue. If you got different answers then the dialogue is in persuasion.* Suggesting she valued discussion for several reasons.

Caz consistently encouraged individuals to offer their ideas and thoughts in whole class discussion. She encouraged them to admit openly and publicly if they found anything difficult or easy after working on tasks at their seats. An example of this was when the class had been asked to partition and found it difficult she stopped to ask what they thought was difficult. *I think (I asked Ben) ...because I thought he would give quite an articulate answer, some of the other children in the class could relate to, and wouldn't be able to articulate for themselves.* Caz believed part of her rationale to encourage children to discuss mathematics was

*it's confidence (building) in maths and it's ok to get it wrong, it's ok when things are hard. Actually if they're hard you are more likely to be learning something. When they say, 'I can't do it, I don't know the answer' they can put a block up. To take that block down I think by articulating maths is hard and that's okay, in a few weeks it won't be so hard.*

The example illustrates how Caz was seen to ask particular children to respond to her questions in order to provide children with different perspectives. She articulated this was a strategy to exploit the way in which children can explain difficulties and complexities of mathematics differently than she is able to.

**Resources, Images and Actions:** In all the lessons observed Caz used a range of resources images and actions to support her teaching. She often referred to the numberline or a counting stick when the children were working with the number system. Caz believed that there are many mathematical resources she can use generically across the mathematics curriculum. For example she used the counting stick to count, but also likened it to a thermometer and bar graph. She explained she thought *It brings the maths together*. She said she did not necessarily plan to use them, but nevertheless will draw images whenever she feels it is necessary. Describing one lesson she said

*I hadn't particularly planned to do a diagram (of a numberline), it was something I decided to do on the spot. I probably was thinking that the children needed something a bit more visual, they had got the counting stick but they needed something (else). She continued '..For some children perhaps the two images combined, would help them understand a bit better. And also it is beginning to relate the counting (of decimals) to a numberline, so when we come to do calculations with decimals, we will be using a numberline so I was starting to show them what that would look like on the board.*

This explanation provides some evidence of how Caz responded to the children's reaction to her explanations in the moment in WCI, making decisions to improve what she was doing and why she decided that it was the right example, in relating to where the mathematics was progressing to.

Caz also used a form of dancing action to reinforce recall of the number system. In one lesson she asked the children to stand up, and in the style of 'Saturday night fever', and shoot their hand and arm up into the air as they recalled the next number. E.g. when counting in tenths the children chanted the numbers up and down the number line in the form of this dance. She said *I put it down in the planning, probably more as evidence for OfSTED, to show that we try to address different learning styles. I think I use it (mostly) when*

*we're counting... in a new way. We get up and dance more for rehearsal than actually learning.* When asked if she believed the children all enjoyed it, she said *you see them doing it in the playground and they go home and show their parents. So yes, it's just another way of presenting something we are practicing, to become proficient.*

**Flexibility:** The structure of her mathematics lessons was not uniformed. She presented a three part lesson as well as a four part double lesson for half the class when observed. She emphasised that she was developing and experimenting with a range of approaches in order to accommodate a 'creative curriculum' that her school had introduced the previous year. She was aware that not everything would work but her intention was to try out a range of ideas to inform both her practice as well as colleagues, which she saw as part of her role as mathematics coordinator in the school. Caz was also seen to adapt and alter her lessons as they progressed. She said she often makes decisions on the *hoof* about the use of images, diagrams and questions as and when they needed to be made.

**Psychology of learning influences.** When Caz discussed any lesson that was observed she would often refer to the way in which she believed children learn and in particular learn mathematics, which for her meant making connections. She emphasised the connections between concepts of mathematics, methods and tools used and real life examples where mathematics can be seen outside the classroom. For example when describing her rationale for using resources and images regularly in her mathematics lessons she said

*I think it's about bringing maths together,... and really you're reducing the work load, the memory load for children if every time you do a new topic it's not completely brand new. You make the links to the other subjects (topics in maths) and of course that's how children learn and the brain works ...so the more you can make those links for the children, I think you even the work load and the memory load.*

The example she gave of this was when discussing the teaching of time she said ...*although you could teach telling the time as a trick. You know, when this hand's here and this hand's there this is what you say. I think that's far more of a memory load than if you actually understand how a clock works and how time works. And then you can work out what you know about time.* Caz often referred to memory or work load when asked about her rationale for what she did in lessons observed. She believed this to be a consequence of her strong psychological background from her first degree.

**Questioning** was also a prominent characteristic to Caz's pedagogical approach to teaching mathematics. She was very much aware of the type of question she asked and why she asked it. When discussing events of lessons together in the SRI, she would often say how she knew that although ideally she should have asked more open questions, she did what she did because of a range of influences including: assessment of individuals or groups, time constraints and extending thinking.

An example of this is where Caz was extending the children's thinking about place value and partitioning of decimal numbers which the children were not very familiar with. Caz said she *was getting the children to think about what they already know so it was quite closed questioning. It was directed at getting them to think what I wanted them to think about.* She said that she would also break down initial questions if at first the children were not able to answer. *Perhaps breaking the question they were confused with initially, down into smaller questions, so that they would get it themselves.* Caz appeared to emphasise a series of strategies such as these, to enable the children to think and work out an answer rather than *her telling children answers.*

**Demonstrating:** Caz demonstrated activities, tasks and ideas consistently in the lessons observed. Caz said that *Demonstration is different to Modelling. It is directing the children's thinking. Giving them questions they could answer and break down concepts of new learning into parts.* She added in a later interview that *Demonstration is demonstrating mathematical concepts.* She saw it as part of her explanation; asking children questions yet seeing it part of a step-by-step progression of building understanding. This conflicts with some of the literature on demonstrating as a teaching strategy. However she was seen to use demonstration as the literature suggests e.g. she demonstrated how to use a protractor in one lesson, then through a series of questions and directions demonstrated how to complete the task step by step, showing and telling the children how.

**Modelling** Caz said she used to show children what and how she wants them to do something, but also the way in which to work and, to some extent, think; which is very different to demonstration as she described above. Caz described what she meant by modelling as

*I would say it is very different... If I'm modelling, then I would work as almost a year 4*

*would work. And I would try to articulate the thinking a year 4 would have and make some of the mistakes that a year 4 might make. I would say things to them... I don't know if I was drawing an array, (I would say) "right first number is 4 so I need four columns and my second number is 5 so there needs to be four dots in each column". And what I expect them to be doing whilst they are doing the work. But then also make mistakes sort of the common errors I'd expect them to make ...to show them that it's ok to make mistakes and how you cross them out and how you go back and check. Just that it will be a demonstration of the whole process I suppose, as I would expect them to be doing it.*

When asked if she thinks modelling is a demonstration, she replied *No it's not it's not. Demonstration is demonstrating mathematical concepts, where modelling is more about me showing them what year 4 should be doing. And how they should approach the maths.*

Thus, she saw modelling as 'modelling a behaviour' of how the children learn. Although she did not articulate this, she was consistently observed to model mathematical language and technical vocabulary with the children.

To summarise this section, the pedagogical approaches listed here were consistently observed in her lessons, and children responded in the manner in which one would expect if these strategies were a regular occurrence in the practice. She was able to articulate general and particular events offering a detailed rationale for doing what she did. The most inconsistent perception she appeared to hold was when she talked about modelling and demonstration, but her most consistent approach appeared to be the encouragement of children to discuss and enquire.

### 5.1.2.3 Classroom Norms

**Questioning:** as already mentioned, Caz was observed to use a variety of questioning strategies for different purposes. She questioned particular groups of children sometimes to assess their understanding of the independent work and she questioned individuals as a behaviour strategy to focus attention. She said that her questioning of individuals is not by chance. *I don't think it's very often random. I think it's more than sort of 90% of the time there will be a reason why I ask a particular child a question.* This was a consistent classroom norm, yet it had two very specific foci, a social one – behaviour, and a mathematical one – asking children questions to develop mathematical thinking. Closed Questioning was also seen to refocus and remind children regularly as part of her everyday approach in the whole class phase of a lesson. As the evidence indicates, Caz had strong and deliberate methods in using questioning which the children responded to as the *normal* expectation of mathematics lessons.

**Open discussion:** Caz appears to emphasise an ethos in her class that encourages discussion about mistakes and misunderstandings the children make. She was aware that children found new mathematical concepts hard, she often talked about events where she gave immediate feedback and how and why it was important to do that in the WCI phase. Of one episode in a lesson, she said

*I think to give as many of the children immediate feedback of how close they were to the minute (activity, when many guessed how long a minute was incorrectly). Not making a big deal of it, but I would like to think it's a class where it's ok to be wrong, so they wouldn't feel 'Oh no I got it wrong!'*

This was reinforced in another interview where she said *what I expect them to do is make mistakes, (I like) to show them that it's ok to make mistakes.* Discussion about misconceptions learning and thinking was a classroom norm, very much focussed on the mathematics, but related directly to life skills in speaking, listening and learning together.

**Thinking time:** Caz mentioned several times throughout interviews, that she was at first concerned about the behaviour of her class when asked to think of an answer. In general they put up their hands or came to the front of the class to demonstrate, draw or write on the board, where they answered a question or an idea to the class, and yet often had nothing to say. They say 'I don't know' or 'I forgot' She said she had found this behaviour unusually regular with this particular class which was frustrating her. She was disappointed with their level of discussion in mathematics, they were particularly passive in their learning skills and she felt she had to work very hard to get them to speak up, argue or question, particularly when she made a mistake on the board. The talking partners approach had therefore been a particular emphasis by her in all lessons and she believed she is just beginning to see the benefits.

**Motivating:** Caz drew from popular TV shows, children's cartoon characters etc. to motivate the children and make mathematics more fun. E.g. she asked the children in a paired game to call themselves John and Edward, rather than number one and number two for the purposes of the game. John and Edward were two finalist contestants on a popular TV programme being shown that week and Caz believed it to be important to use characters and events from the children's real life. She said she did this *Just because it just makes it more fun. You are doing exactly the same thing, but for the children who, well it makes no*

*difference to me (Laughs), it sort of makes them smile and relaxed and ready to do what you've asked them to do without them feeling any fear of maths, because they're thinking more about John & Edward for a second. It's distracted them.* Yet the game was still drawing on their mathematical knowledge.

**Learning Objectives:** The learning objective is usually displayed everyday on the board, though not in detail, for example the board may say *we are learning about fractions* and would be displayed for several days as they progress through a collection of learning intentions on fractions. Caz believed the children needed to have a range of differentiated learning intentions which are related to the level children are working at, and discussed in class together rather than leave it as an item on the board they copy in their books. In one example she wrote on the board 'we are learning about multiplying by 10 and 100' by increasing the mass of a selection of cakes drawn on the board. She said, *I want them to remember we were doing multiplying by 10 and 100 and not learning about cakes!* Caz said she was aware how some teachers were writing detailed learning objectives on the board but also success criteria too. Although success criteria differentiated the activities, she believed these to be trivial, simply a context in comparison to what the mathematics learning is. The context she believed supports delivery rather than differentiates the mathematical learning. Here too her focus was the importance of emphasising mathematical norms in her practice.

To summarise this section, Caz has strong views on how she wants the children to engage in the learning of mathematics. She indicated that she would offer context which does not fundamentally change the mathematics learning, it simply presents mathematics to the children. There are distinct patterns to Caz's practice which appear to be emphasised through her level of questioning and presentation, reinforcing the idea there are specific classroom norms to her practice. Her views of teaching focused on *mathematical behaviour* rather than the social behaviour of children. The only events observed where behaviour of the class was an issue is related to the frustration Caz demonstrated when the children do not take the time to *think* about questions she had asked, before attempting an answer.

### 5.1.3 Conclusion

Caz's preliminary interview highlighted six key mathematical teaching approaches as emblematic of her teaching practice. The observations and SRIs identified a broader set of strategies, some of which resonated with the original six, some of which did not. Table (5.1) below summarises these strategies, framed by the three categories of practice as discussed above: Mathematical Intent, Pedagogical Approaches and Classroom Norms.

| Comparison between:                                | Espoused beliefs about her practice | Enacted practice |
|--|-------------------------------------|------------------|
| <b>Mathematical Intent</b>                         |                                     |                  |
| Making Connections                                 | ✓                                   | ✓                |
| Prior Knowledge                                    |                                     | ✓                |
| Proficient recall of facts                         |                                     | ✓                |
| Mathematical reasoning                             |                                     | ✓                |
| Mathematical tasks                                 |                                     | ✓                |
| Vocabulary   |                                     | ✓                |
| <b>Pedagogical Approaches</b>                      |                                     |                  |
| Modelling  | ✓                                   | ✓                |
| Demonstrating                                      | ✓                                   | ✓                |
| Questioning  | ✓                                   | ✓                |
| Explaining   | ✓                                   |                  |
| Discussion   |                                     | ✓                |
| Choices: Resources, images and actions             |                                     | ✓                |
| Flexibility  | ✓                                   | ✓                |
| Attention to psychology of learning                |                                     | ✓                |
| <b>Classroom Norms</b>                             |                                     |                  |
| Questioning  | ✓                                   | ✓                |
| Involve children in their learning Open discussion | ✓                                   | ✓                |
| Thinking time                                      |                                     | ✓                |
| Motivation   | ✓                                   | ✓                |

Table 5.1: Caz's espoused and enacted practice compared

The table above illustrates there are indeed similarities and differences between Caz's espoused and enacted practices. The observations and SRIs, however, identified nine other emphases from Caz's practice which were not explicitly emphasised in the initial interview most of which were directly related to the mathematics, not a teaching strategy. She also held strong ideas as to why she emphasised these MIs in her classroom, some were planned for, some were not, as explained earlier. The eighteen emphases listed in the table above will be analysed and discussed in-depth later in chapter nine and ten. Having presented the case for Caz, I will now move on to introduce Fiona in the following chapter.

## Chapter 6 The Case Study of Fiona

The structure of the case study presented here are in two parts, as described in chapter five, which help to highlight particular characteristics of each teacher's beliefs, attitude and teaching practices. Utterances made by the teacher are presented in all cases in *italics*.

### 6.1 Background: beliefs, attitudes and influences on teaching

This first section provides a summary of the semi-structured interview at the start of the second phase of the study, and offers background information for teacher Fiona and the context in which she works. It is presented through three categories which detail elements of her beliefs, attitudes and preferences towards the teaching of a whole class phase of mathematics lessons.

#### 6.1.1 School Context

Fiona was a year one teacher in a two form entry primary school in a low socio-economic town. When she agreed to be part of the research project reported here, she taught at a different school in the same town, but was a teacher in a year two class. She had been teaching at the later school since leaving her BA QTS course as a mathematics specialist, and had been the numeracy coordinator. It was a large three form entry primary school in an urban setting, one which she had worked in as full time and then later part time whilst raising a family. She was not very happy at this first school; her classroom was a corridor with no white board and very few resources. Mid-term, during filming this research project, she moved schools and year group but wanted to continue working with the project. Therefore the first lesson was observed in her year two class, and the following two lessons were filmed in her new school, in a year one class. The new location was a similar urban school with a two form year entry. She was working full time again and enjoying her new challenge. Although this change could have proved to be problematic for the study, it has offered a useful perspective on if and how a teacher might alter or refine their practice when changing school and year group. Fiona stated that she had always wanted to work with young children as she felt more comfortable working with the '*younger ones*'. She had always worked in key stage one since qualifying.

#### 6.1.2 Belief Formation towards mathematics as a subject and as a teacher:

She chose to specialise in mathematics because *I quite enjoy mathematics. I think the challenges in mathematics are quite interesting.* *I wasn't the very best at maths, but I did*

*like trying and finding out, even when I was at school... I asked for extra homework, I must be mad. So it seemed the natural choice (to specialise in). Fiona went to a private school until the age of 16. She only remembers doing School Mathematics Project (SMP) cards in lessons and loved to whizz through them. She said she enjoyed working through the textbooks doing column addition and subtraction, and had a lovely teacher so had a very good experience. She believed she has always been academically successful, as I always tried really hard in everything I did.*

Fiona does not recall anyone in particular who may have influenced how she approaches mathematics teaching, but if she saw or heard of a good idea, she would incorporate this into her own style of teaching. She said *I've developed my own style of teaching, like everybody does, ... I've got lots of ideas from people. I'm always open to new suggestions and I've just incorporated everything into my own teaching and made it my own.*

Fiona stated that she liked to challenge her pupils. *Particularly now I've been working with the top ability, they enjoy the challenges and you know that they can apply themselves a bit more than perhaps the lower ability children will, they understand it a bit better. If it's a new concept starting off with quite easy stuff and then building on that very quickly... Giving them the confidence to try and do it. When they say, I can't, I can't I can't, build on that confidence and say, have a go, it doesn't matter if you get it wrong.*

When asked how the children might view their mathematics lessons she said that she hoped *they'd say they're exciting. I try and cater for visual, auditory, and kinaesthetic in my lessons so hope they would pick up on that. Each of them would get something out of it, each of them would find something of that lesson very interesting. They might say some things are too hard, whereas I say it would be challenging.*

Fiona enjoyed teaching shape, *because you can do it very practically* she said. She also enjoyed patterns, *I think there's so many things you can do, making patterns with it and pictures and whatever, and addition I like teaching. Getting all the vocabulary lots of, sets of, groups of, etc. where they count how many sets, so that's so many times three blah, blah, blah.. We might stand up and do the marching and do it direct: three times dee dum dee dum... And all that...we do it in minute maths. Finding patterns in the multiplication tables, I think is quite fun. Either setting them challenges to find it themselves or, if they haven't spotted it, explaining it to them.*

To summarise, Fiona was not happy in the classroom she was in, essentially it is an expanded corridor, at one end there were two doors to other classrooms, at the other is a set of double doors to the rest of the corridor beyond leading to the hall. She found it a difficult environment in which to teach. She liked to use interactive displays that were colourful and visual, as that was her learning style she said. Resources readily available were also very important to her in supporting whole class teaching. Although there were mathematics resources available to her and her class, many were in a resource room in another part of the building, which she found difficult.

She felt restrained by the framework *There's so many things packed into the framework, you never get round to teaching every single thing as you would want to teach it. You can't extend on anything too much because you've got to get onto the next area of learning. I think there's too much in it.* She added *I think there's too much pressure on teachers to teach everything in it, especially when it comes to the SATs. Ugh! You end up teaching things because they might be in the SATs, and that's not the way it should be done, at all.* She implied she felt constrained.

### 6.1.3 Belief Manifestation in practice

This section of the preliminary interview provided insights into how Fiona perceived her own teaching of the subject through her pedagogical approaches in general, but in mathematics in particular and how she managed WCIT phases as well as what a typical mathematics lesson might look like.

Fiona really enjoyed talking to her class on the carpet. *I like the closeness of it and having them all together, having them all listening attentively... I don't like it when they start fiddling, they have to be attentive. I especially like it when they're doing things together on the carpet in their talking partners.* Although Fiona expressed a preference to closeness with her class, she emphasised that *closeness* was about the children being quiet and attentive.

She enjoyed a starter in which she encouraged the children *into the mindset of the numeracy lesson, getting their brains working straightaway, rather than having a slow introduction into the lesson and then, maybe they start to get a bit bored.* She talked about how her *oral-mental starter it's quick, quick, quick ...they start thinking straight away.*

For Fiona the learning objectives were the most important aspect of the main phase of a lesson *their understanding of what they're going to learn, the purpose of the lesson, so going*

*through the learning objectives was most important, I want them to understand why they're learning what they're learning. But I want them to understand what they're going to be learning about, not in too much detail, as I don't want to bog them down. She also emphasised the importance of success criteria in the WCI phase of a lesson. I might do it straight after I've explained the learning objectives, what are you going to be able to do at the end of the lesson, and they tell me and I'll write them down. Or I might do it at the end of the lesson, or review what they've done. I think that's very important as well.*

Finally Fiona said, *personally, I love having them listening to me, you know, hanging on my every word, most of the time.* She said in some jest.

*I like the different ways that they can answer you, so I can either say, right, everybody call out at once or it'll be hands up or hands down or I'll pick children. I like it when they're in their talking partners, I'll go round and listen to what they say. If you ask somebody to come up and do something on the board we give them a cheer or clap, I like that.*

She said that she encouraged this to give them confidence and to keep their self-esteem up. She said

*it depends on background, home life and, how they are with their peers. So I think if you actually give that support and encouragement within the classroom, it gives them a bit of a boost. I think I try to be quite positive even when they get things wrong, I'll say, well, good try, well done, thank you for trying et cetera. But I think if you're not, if you're more strict and set in your ways, I suppose, you say, No, that's the wrong answer, next you know ...I don't think you can take that approach with young children.*

She described her teaching style as *friendly*.

A typical lesson would be in three parts *where they will do a quick oral-mental starter first.* This may be with something called

*minute maths where they're given a strip of sums or multiplications and I give them exactly one minute, to write down as many answers as they can, they continue that same strip of paper each week. When it's filled out, they get another one, et cetera. So it's either the minute maths or the oral-mental starter. And then... we will do a bit of a brain break. And then go on to our main activity.*

A brain break refers to a whole school policy in breaking up episodes of lessons to help the attention of children. The school in which Fiona taught considered the school to be in a *difficult catchment area, where there were low socio-economic family problems.*

#### 6.1.4 Summary

To summarise this section of Fiona's espoused beliefs and attitudes to mathematics her personal orientation can be summarised as:

- She found the subject easy at school and university
- She greatly enjoyed working through books, cards and sheets
- She enjoyed the *challenge* mathematics offered her
- She believed the approaches in teaching are better now
- She was influenced by previous teachers she has worked with.

Finally embedded in all the above were a number of pedagogical practices presented as elements of her day to day working, there included:

- **Connections:** Making links between the starter activity and the main part were the only connections Fiona referred to.
- **Prior Knowledge:** Fiona activates prior knowledge to develop new learning
- **Discussion:** Talking partners were used in whole class phases to listen into the children's paired conversations
- **Explaining:** Fiona emphasised the importance of explaining the learning objective to the children in the main part of the lesson, to ensure the children understood what they were learning. She also emphasised the importance to the success criteria, which she said she involved the children in. She also thought it important to ask children to explain to the class in whole class phases of a lesson.
- **Questioning:** was seen as part of developing individual's confidence through inviting children to answer questions, handle resources and build self-esteem. Building motivation through praise and encouragement.
- **Modelling:** Involve children in their learning e.g. invite children to come to the front of the room to write or mark on the board as part of the whole class interaction between children and teacher.
- **Resources:** Fiona believed that resources were essential as children are motivated by handling resources.
- **Fun:** Fiona believed she emphasised fun lessons to motivate learning of the subject
- **Flexibility:** She believed that learning styles were very important in her approach to planning teaching and learning.
- **Brain-breaks to aid concentration:** Fiona believed it important to have a *brain break* during lessons to aid concentration of the children. She believed that a very important aspect of her role was to motivate children and build confidence through praise and development of self-esteem.

## 6.2 Overview of Practice

This second section presents a summary of the three lessons observed and then later discussed through stimulated recall interviews (SRI) to allow reflection. The presentation of this section has been separated into three categories:

- **mathematical Intention;**
- **pedagogical approaches**
- **classroom norms (behavioural approaches).**

Each category presents the data that characterise the enacted practice observed in the three lessons. Each item has been supported by examples of events consistently observed or comments consistently made or emphasised by Fiona in the SRI providing evidence of the way in which she conceptualised her practice. Comments made by Fiona are represented here in *italics*.

### 6.2.1 Mathematical Intent

**Prior knowledge** was activated in every lesson observed through Fiona's explicit statements and her questioning in response to children's comments, for example she would ask the class if they remembered how they had added or subtracted in previous lessons. In her post lesson interview we discussed a question one child asked her following her explanation that they were going to count in twos. One child shouted out *What does that mean?* She said *I'm sure we've done counting in twos before but not like that.* She thought they were a little confused as she was using money (2p coins posted into a money box). She added *the focus was counting in twos not money*, although she did not make that explicit to the children in the lesson. She emphasised in her interview that *...because it was something different to do, something a bit more challenging than just sitting there reciting in twos. Just to get them a bit more stimulated.* Fiona was very keen not to give children mundane '*boring*' activities which will be discussed in the next section - pedagogical approaches, in more depth.

**Mathematical vocabulary:** Fiona consistently emphasised key mathematical vocabulary throughout her lessons. She would repeat the key words over and over to the children and ask them to say it after her, sometimes writing them on the board. Following the framework was the rationale she gave for this action, she said *I want them to begin to recognise the words when they're written down, because in the framework one of the things is to begin to write down.*

She was also seen to use games to emphasise children's use of vocabulary, or particular phrases, drawn from the framework. When discussing one activity she said

*I wanted it to be a different activity coming away from the number lines, because they had been working so hard at that, and I chose the box (a covered shoe box), because I wanted them to think about the vocabulary that's involved, using subtraction as well using less than.*

In one lesson Fiona explained that she always read out the learning objective as they were presented on the class board just as they are in the strategy framework. She said the *learning objective is from the framework so I wanted to make sure that the children understood what it meant, in their vocabulary*, e.g. *to partition a two-digit number*. Fiona often talked to the children about mathematical vocabulary and corrected them when they got it wrong e.g. repeating the words correctly as in one lesson '**seventeen, not seventy**' emphasising the endings, but was not seen to relate the numbers to the system through the use of a number line or grid etc.

**Connections:** Although Fiona made relational links between concepts within mathematics, the emphasis was on the resource and not the mathematics. For example: between IWB place value cards and partitioning with the use of cubes to illustrate the concept of partitioning two digit numbers. She said

*I've used those two together before and it's been successful. I used the Place Value cards that they hold which are better. This was good because you could see how the numbers began in their tens and units and you could put them together and partition them again, like the children needed to know. What I would have liked to use are the smaller Place Value cards at their tables, but unfortunately we didn't have the resources for that. So the next best thing was cubes... and to try to relate the partitioning and making towers of ten to relate to the numbers.*

I asked if she felt restricted by the fact that she could not use the resources she would have preferred to use, but she had not thought about there being an issue if the resources were not available to her.

To summarise these points, it was apparent that Fiona had little to say about the children's mathematics learning and understanding, she emphasised a methodical yet procedural or *Instrumental* (Skemp, 1976) approach to teaching mathematics through each of the above features. For example, Fiona appeared to reactivate prior knowledge by asking questions about previous mathematics lessons, however the prior knowledge was not seen to be related to different aspects of mathematics or indeed other areas of the curriculum and

children's learning. Instead it related to the context or the resource used. Key vocabulary were explained to the children in great detail through definition and fact, little or no explanation or relationship made for the children to make explicit connections with other words or learning. Fiona provided detailed mathematical learning objectives as already alluded, however, the explanations were about 'what' the children are learning, not 'why', other than the children *need to know this*.

Fiona was filmed in two different classes of a year one and a year two, the mathematical emphasis appeared similar in approach and presentation. She explained that she believed both the classes were well below the national average and was therefore a difficult task. She talked about ability groupings but little emphasis was recorded in whole class phases of a lesson that supported that idea, most discussion was focused on the lowest expectations. The differentiation appeared solely to be emphasised in the seatwork that followed WCI, e.g. seen through the numbers the children were working with e.g. 0-5, 0-10, 0-20 or 20-100.

### **6.2.2 Pedagogical Approaches**

Fiona emphasised her pedagogical approaches in her initial interview, however, many more were revealed through the observation of her lessons. This section is again presented through themes drawn from the individual case data coding (example of which can be found in Appendices: 6.1 which presents the first level of analysing lesson content against SRIs, and 6.2 which presents the second level of analysis of lesson under categorisation headings).

#### **Resources, visual aids and practical equipment.**

Fiona was observed to use many practical pieces of equipment in her teaching, for example she used two pence coins dropping into a metal money box and asked the children to 'visualise' the counting of the coins (counting in twos). Shopping items were used to identify 3-D shapes, she said

*well I didn't want to use the same old boring things out the drawer that we always use that don't have any relevance to real life really ... so I raided my cupboard to find some different shapes. Everyday items that they would see, for them to realise that shapes exist in real life not just in school or out the drawer.*

Not all items were explicitly typical, for example a peanut butter jar was introduced as a cylinder.

She was regularly seen to use a covered shoe box (similar to figure 6.1 below) which contained a set of cards, either with questions such as  $7+4=?$  written on them, or a number between 0-20. The children appeared to be familiar with this box of cards which implied this was a regular resource used by Fiona. When discussing its use she said *I chose the box, because it's exciting picking something out of a box, because they don't know what they're going to get.* She added that she believed the use of the box involved all the children *so that the whole class is thinking about that number not just that one child, also to help that child if they did get stuck, to give them some support from their peers, is just a nice practical way of doing it.*



*they did get stuck, to give them some support from their peers, is just a nice practical way of doing it.*

Figure 6.1: Covered shoe box

Linking cubes (like the cubes in figure 6.2 below) were used in one lesson to make towers in support of children's understanding of partitioning. She explained that she used them to demonstrate what they were expected to do in independent seatwork, which was to represent a two digit number, for example: one tower of ten cubes and a smaller tower of five cubes to represent fifteen, one ten and five ones, (or units).



Figure 6.2: Linking cubes

**Questions** were used extensively throughout her three lessons. Fiona explained that she asked questions for particular reasons such as a reminder for children, to challenge, to motivate and to develop thinking and differentiate WCI phase. Indeed every lesson began with a question e.g. *Who can tell me what we were learning about yesterday?* to remind them of previous work. Fiona was seen to reactivate prior knowledge and understanding at the beginning of every lesson observed through questioning. She said it's *basically to remind*

*them what's been going on, and I suppose also for me to realise how much they have learnt from those lessons and if there's a gap in that learning, I can quickly change my plan of what I am doing.*

Questioning was also used by Fiona to motivate children and alter pace she said, when the WCI phase is *dragging on a bit, I need(ed) to speed them up*. She spoke of one episode that the *middles and the lowers were just taking so long to get round to the answer and relying on me a bit too heavily so 'right come on then, we'll do this one quickly' and get going, come on try doing it yourself quicker, so to motivate them really*.

Fiona often commented on how poor some of the children's knowledge about numbers was, she said she used questions to differentiate for individuals, for example *he's one of the lower abilities, so that was the reason why I asked him what the number was. I think I (asked) everyone though because they were quite poor on recognising numbers*. In Fiona's initial interview she said that she used talking partners in WCI phases of a lesson, but this was never observed in her practice. She asked closed questions and then asked individuals to answer. Sometimes she took what the individual had answered (IRF<sup>1</sup> method), but at other times she was seen to gather several children's answers before telling them if they were correct or not. She was observed to regularly repeat the children's responses which she explained were for two reasons: Firstly to make sure she had understood what their answer was, to check and assess their responses, secondly to make sure all the class had heard *I tend to do that a lot. It's just a habit. I think the main purpose of it really is to let other children know what he's said... children often speak very quietly and other children don't often pick it up. I also repeat it for my understanding of what they've said I think*.

The **learning Objectives** were always observed to be emphasised by Fiona in every lesson. This was seen in two very particular methods of explication. In her first school she presented the learning objectives on her laptop screen for the class to see as they sat on the carpet. In the initial school, Fiona said that *it's the school policy that we introduce the objectives to the children, and this is the way that I display it on the smart board* (referring to laptop software). She read through the learning objectives as an explanation of what the children would be doing. In her second school, she referred to a hand puppet to tell the children

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<sup>1</sup> IRF: Initiate Respond and Feedback (Sinclair & Coulard (1975) as explained in literature review

what they were going to learn in their lesson. He was called: Learning Lion (see figure 6.3 below).



Figure 6.3: Learning Lion puppet

She said that *The Learning Lion is to do with the learning objective and so the children know what the lesson is all about. Learning Lion is just a stimulant for them really, get them motivated and we've got the puppets to help with that as well as the pictures on the smart board.* She was referring to a picture of a cartoon lion character which was placed by the list of learning objectives on the interactive white board. She continued to say that '*It's a school....thing. So it's the same for every class... I think.'*

The IWB screen showing Learning Lion (learning Objective)and Successful Snake (Success Criteria) were seen as shown in the figure below.

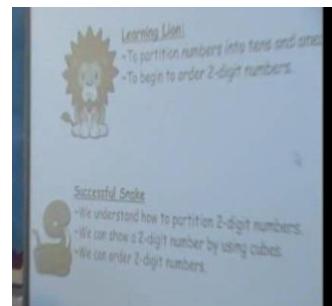


Figure 6.4: IWB image of LO and SC

The **success criteria** were observed to be part of every mathematics lesson, whether presented as 'steps to success' or 'successful snake' which she used according to the respective school policies. Fiona believed that it was good practice to display the learning objectives and success criteria. She said although *it is a school policy I have been doing it for quite a while anyway, I think when it was very first introduced, because I thought it was good practice.* She used this opportunity to *gather their ideas of what they've learnt during the*

*lesson. And at the beginning of the next lesson if you are doing the same sorts of things, just to remind them what they've done.* She strongly emphasised that it was used as a reminder of what they are doing. Here is an example of the criteria listed on the board in one lesson observed:

SUCCESS criteria:

1. Count carefully
2. Count backwards
3. Use your sticky finger to point to the numbers
4. And when you count backwards you are taking away
5. You have got to find the right number to start from
6. concentrate



Figure 6.5: Successful Snake puppet

Successful snake, as pictured above (figure 6.5), was introduced to Fiona at the same time as Learning Lion in her new school. She explained that *Successful Snake is what you want them to achieve by the end of the lesson. Or sometimes we use it to get them to tell me what Successful Snake should have said, because sometimes he's naughty and he forgets to say things, which she said was absolutely hilarious, they tell him off and then they tell me what to type in for successful Snake should have said.*

**Low ability children:** Fiona believed that the children she worked with were *below national standard* in both schools and classes she had been filmed as they accommodated low socio-economic catchment areas and so this would be reflected in the classroom. She was particularly concerned with the middle and lower achievers in her year one class *they are below the expected standard, and they came in like that in September so everything is still a bit behind, we still need to close that gap, it's very difficult to get them up to standard, it's*

*going to take a lot of support.* She believed she would have to work well below the national average in the mathematics curriculum.

The **Oral Mental Starter** (OMS) was an important part of the structure to Fiona's lessons. She said she liked the focus to be a different area of mathematics to the main part of a lesson, or at least a different activity as she believed it to be *boring* if it was not. She said *I do like to differentiate the OMS to what we're doing, because I think it gets them stimulated more. If they were doing the same thing the whole lesson long, it can get a bit boring and drag on a bit for them.* In her initial interview she said she made links between the oral mental starter and the main activity of the lesson, but this was not observed in the lessons seen, they were often different or no explicit link was made to the children.

**Practice makes perfect:** Fiona explicitly introduced lessons as practising lessons e.g. *today children we are going to practise our addition targets.* In one lesson she reminded the children of their numeracy targets, which were displayed on the wall as planets with children's names attached to the target (planet) they were working on. Fiona emphasised how important it is to repeat and practise everything she said because *we don't want to forget it do we!* She had a saying in class *the more we practise, the more we learn.* Fiona said she would often repeat activities to get the children *practising* mathematics e.g. identifying shapes. A further example was seen when she was explaining how they were to record their word sentences, e.g.  $7+4=$  she told them to write the equals sign in the air for her to see. She explained, or justified, to them that it was good to *practise* writing out the equals sign. Fiona did not model this to the class, she used this to assess the children.

**Explaining:** Although Fiona was seen to take many opportunities to *explain* to her class all sorts of aspects related to her mathematics lesson, she did not often use models or demonstration to support her explanations. She had difficulty articulating this element of whole class phases, she agreed that she explained things to the children, and might ask a child to do this too, but her emphasis was on 'This is what we are doing... and This is how we do it....

**Prompting and telling** was a key feature of Fiona's practice. When counting backwards to subtract, for example, the children struggled so she prompted them by counting with them, she said *sometimes I find that when I start counting for them, they realise the rhythm and pattern so come up with the answer.* She implied this was to *scaffold children's*

*understanding*, if no answer materialised she used other counting strategies e.g. recall a rocket rhyme where they count backwards then jump up in the air after ... *one...zero...blast off!* Another strategy Fiona used was gesturing, for example when adding two numbers 5+4, she gestured with her right hand as if holding something and then places it on her head to suggest placing the number inside her head, saying 'five' (goes in the head) and then counts with her fingers '6,7,8,9' (adding on four more). The children are expected to copy her, she said *I taught them that strategy, I think that's one of the easiest ways of counting on so I always stick with that strategy.*

**Motivation** was emphasised by Fiona throughout her practice. She would often pretend that she does not know her mathematics and so needs the children to help her. She also played the 'devil's advocate' to some extent, mimicking a child-like voice as she did so, she said she did this *because they find it quite funny when I don't know things. And I do try to make my lessons fun for them because it's nice for them to have a laugh, rather than just saying right here's a shape what shape is it? That's boring!* Although children did not appear to be amused by this approach when we watched the video-tape back, we cannot be sure that they do not find this approach amusing.

**Assessment:** is a key feature of Fiona's teaching approach. She was observed to assess continuously throughout the sessions in WCI, for example to check children's understanding of vocabulary used in the learning objective and success criteria in great detail. She also suggested that although she chose children randomly to answer her (closed) questions, she would use that as an opportunity to assess individuals regularly.

To summarise this section, it appeared that Fiona emphasised teaching mathematics through a description of the learning objective and success criteria, then assessed the class in WCI phases. There were a wide range of strategies seen in the lessons observed, from very little teacher input, where the reading out the learning objectives and success criteria followed by instructions of what to do in their books, to observing a plethora of explanation. For example, detailed stepped instructions were given on how to use place value cards, on an IWB, alongside building towers of linking cubes to model partitioning of two digit numbers. Many resources were used in lessons yet little discussion, or explanation to children was offered to explain *why* the resources supported their mathematical thinking, or *why* or *where* the connections were to their previous learning.

### 6.2.3 Classroom Norms

**Motivation:** Fiona described the reasons why she used particular methods or approaches in teaching mathematics were to stimulate, challenge and motivate children. She mentioned several times that she did not want her lessons boring so she was always mindful of this e.g. dropping two pence coins into a box to count in twos; using a covered box of number cards rather than writing or telling the children. In her opinion, this was more exciting for the children. She said she regularly counted back from twenty with the children pretending to be rockets, as described earlier, and other such regular routine rhymes to focus children's attention on their work and their thinking in WCI phases . The strategies she used consistently when observed were:

- A random gathering of children's answers to whole class questions. She believed it to *make sure that everybody is focussed.*
- Sitting children in a circle as *they do tend to focus more when they're in a circle, because they've got things to look at, they've got each other to look at.* She tried to make sure children all got a turn to say or do something to motivate them to take part.
- Fiona used brain breaks regularly in all lessons observed *it's something I like to do in the classroom as I know they can be sitting down for a long time. They need to stand up and become a bit more active so I don't lose their focus completely, I want them to have a break from it. So this is called a brain break.* She was observed to use a range of ideas read out from a set of instruction cards she had.

**Fun:** Making mathematics lessons fun was a key aspect to the way in which Fiona said she presented mathematics to the children. Fiona was seen to use a game-like approach consistently at the beginning and end to her mathematics lessons. She stated that this was a purposeful method to both reactivate and remind children of what they had just been doing or what they had already done in previous lessons. In one lesson, Fiona referred to a 'sticky finger', the meaning of which related to using a finger to move along a number line when taking away, which the children were familiar with. Using a sticky finger was also included in the success criteria, her rationale for this was one of *fun* for the children, as one child had mentioned their finger was sticky in a previous lesson.

**Performance targets:** Fiona displayed all the children's targets in mathematics on the wall as directed by her senior management team (SMT). She talked about this as *a fait accompli*. She offered no rationale or explanation for this strategy.

**Practice:** Fiona emphasised what she called 'good habits' to the children, regularly telling them how important it was to 'practise' their mathematics. In WCI phases, as already reported earlier, Fiona often stated to the children how important it was *practising things*: *Practise makes perfect*. She would repeat the phrase and would also announce to the children *the more we practice* and the children would respond *the more we learn!* in a collective conditioned response. Fiona believed this approach was part of her role to teach children *the basics* of mathematics which is a phrase she used.

**Gestures:** Fiona often used dramatic and emphasised gestures e.g. pretending to place the first number of an addition sum into her head and hold it there with her hand. She then held up her fingers and counted on from that first number. She believed this to help children remember how to calculate.

The most notable consistency in all Fiona's lessons are the emphasis on stimulating the attention of children. Although *basic mathematics* and *practising* were key phrases explicitly used with the children, it appears the emphasis is on children's social behaviour rather than a mathematical behaviour. She encouraged the idea that children should have fun, but very little appeared to refer to the enjoyment of mathematics and its connections and structure in this emphasis.

### 6.3 Conclusion

Fiona's preliminary interview highlighted ten key mathematics teaching approaches as emblematic of her teaching practice. The observations and SRIs identified a broader set of strategies, some of which resonated with the original ten, some of which did not. Table (6.1) below summarises these strategies, framed by the three categories of practice as discussed above: Mathematical Intent, Pedagogical Approaches and Classroom Norms.

| Comparison between:                                      | Espoused beliefs about her practice | Enacted practice |
|--|-------------------------------------|------------------|
| <b>Mathematical Intent</b>                               |                                     |                  |
| Making Connections                                       | ✓                                   |                  |
| Prior Knowledge  | ✓                                   | ✓                |
| Vocabulary   |                                     | ✓                |
| <b>Pedagogical Approaches</b>                            |                                     |                  |
| Use of Resources and images                              | ✓                                   | ✓                |
| Questioning  | ✓                                   | ✓                |
| Learning Objectives                                      |                                     | ✓                |
| Success Criteria   |                                     | ✓                |
| Mindful of Low ability                                   |                                     | ✓                |
| emphasis to make mathematics fun and exciting in the OMS | ✓                                   | ✓                |
| Explaining: Prompting & Telling                          | ✓                                   | ✓                |
| Discussion   | ✓                                   |                  |
| Modelling  | ✓                                   | ✓                |
| Motivation<br>Brain-breaks to aid concentration          | ✓                                   | ✓                |
| Practising   |                                     | ✓                |
| Assessment   | ✓                                   | ✓                |
| <b>Classroom Norms</b>                                   |                                     |                  |
| Motivation   | ✓                                   | ✓                |
| Fun  | ✓                                   | ✓                |
| Performance targets                                      |                                     | ✓                |
| Practising   |                                     | ✓                |
| Gestures   |                                     | ✓                |

Table 6.1: Fiona's espoused and enacted practice compared

The table above illustrates there are indeed similarities and differences between Fiona's espoused and enacted practices. The observations and SRIs, however, identified seven other emphases from Fiona's practice which were not explicitly emphasised in the initial interview. An interesting comparison between the espoused and the enacted is Fiona emphasises many of the structural elements e.g. the importance of learning objectives and success

criteria in her approach to whole class teaching. Interestingly only two mathematical intentions were identified as key emphases by Fiona in practice, although she made connections in her WCI phases, they were not mathematical connections. She was very enthusiastic about making her lessons fun and exciting, using many resources to motivate her class, but little flexibility was observed in critical moments of WCI. She was particularly keen on practising ‘the basics’ of mathematics, which she implied was early calculation and place value. The eighteen emphases listed in the table above (some duplicated through the classroom norms) will be analysed and discussed in-depth later in chapters nine and ten. Having presented the case for Fiona, I will now move on to introduce Gary in the following chapter.

## **Chapter 7 The Case Study of Gary**

The structure of the case study is presented here are in two parts, as described in chapter five, which help to highlight particular characteristics of each teacher's beliefs, attitude and teaching practices. Utterances made by the teacher are presented in all cases in *italics*.

### **7.1 Background: beliefs, attitudes and influences on teaching**

This first section provides a summary of the semi-structured interview at the start of the second phase of the study, and offers background information for teacher Gary and the context in which he works. It is presented through three categories which detail elements of his beliefs, attitudes and preferences towards the teaching of a whole class phase of mathematics lessons.

#### **7.1.1 School Context**

Gary was a year five teacher in a two form entry primary school in an affluent part of a large town. He had been teaching at the school since achieving his BA QTS course. He had taught for over four years and worked in years three and six before moving into year five. He explained that having taught in year six he now knew how to prepare children for year six SATs. During his BA QTS, he trained as a mathematics specialist, but it appeared this was by accident rather than design as he wanted to be an ICT leader. He enjoyed teaching the subject and had hoped to become the numeracy coordinator in his school. He was in the process of applying for Leading Mathematics' Teacher (LMT) status, which he believed would improve his promotion opportunities. He was very happy at his school believing it to be one of the best achieving schools in the town.

#### **7.1.2 Belief Formation towards mathematics as a subject and as a teacher**

Gary remembered little about his early education, but *did* remember writing *lots and lots of pages of sums in maths*. He recalled sitting at a table with no resources, *very much a sit down, shut up, do what's on the board, sort of* experience. At upper school, he was in the top set and achieved well at GCSE. He studied mathematics at A' level, pure and applied, but found the transition difficult as his teacher changed and he fell behind the others in his class. He said all his friends appeared to be doing fine but he *just didn't get it*. He believed he had a *different intelligence; I'm not a book worker, I couldn't do lots of algebra. My brain doesn't work like that. I can stand up and do a play to hundreds ...that wouldn't bother me*. He left school without completing his A' levels and got a job as a trainee manager in a large

supermarket chain, following this he worked as an engineer before a teacher friend encouraged him to become a primary teacher. He commented this seemed a natural progression as he had been a cub leader for some years and also taught sign language to adults. He worked for two terms as a classroom assistant before commencing his three year degree course.

Although he had expressed a preference for ICT, his university did not offer an ICT specialism, he was happy and confident to take a mathematics specialism. He commented that his various jobs in industry allowed him to regain his confidence in mathematics through *constantly working with numbers, percentages and adding and taking stock, sales figures*, so he felt he began his degree course very positive and self-assured.

Gary spoke about his tutors encouraging him and his peers to discuss mathematics which taught him *a different approach* to the subject. He commented also, on how he worked with a small group of friends who would *revise and revise, working with little (prompt) cards. Our learning styles were very similar*, and this helped him prepare for his examinations. During this last year the higher level mathematics began to make sense. He said that all he needed was for someone to tell him how to do it, he *did it and practiced it. If someone tells me how to do something I'll do it straight away. I don't question it, I just do it.*

As a teacher of mathematics, Gary enjoyed his work. He enjoyed watching the progress children made, *when you get that..."Oh yeah! I get it now" and they go off and do it.* He said he liked *the physical get up and move activities* adding that *in primary that should be with all subjects now... move activities as with brain gym.*

His interview took place at the end of the summer holiday and seemed excited and eager to get back to his new class. He talked about his school's focus on mathematical achievement and *the fact that we need to bring our maths up.* To do this ...*we've moved year six teaching down to year four and already we're seeing the results that the year four children are coming up higher, and so our year five children, now, are at the same level that year six were last year.*

He emphasised a strong senior management directive in how he approached mathematics. He explained *we used to do success criteria until last year and then our new numeracy coordinator took over and she was very adamant that there should be these top tips. So it's now gone on to top tips although that doesn't work so much in other subjects. In maths*

*that's how it needs to be done.* He went on to explain how they would always be expected to share the learning objectives and success criteria with them.

*Sometimes you just physically didn't have the time to (write up all the success criteria and learning objectives on the board first thing in the morning), so we'd write them, under paper, and then whip the paper off. I fell down a couple of times because I didn't put success criteria up and our head will ...do spot checks on learning objectives and success criteria on the board. And I got caught out because it wasn't on the board. So now, more often than not, I'll put it on the board just to make sure I don't get caught out. Cos I hate being caught out, especially when he asked a child whether he knew what their success criteria were, but it wasn't displayed on the board. So, I will make sure it's written on there.*

He was asked if he thought that was very structured. He said

*Yeah ...it's the school really. That's why I think I enjoy it so much, because, I'm very autistic. I like everything in its place. If someone tells me, you need to do your newsletter to parents by Wednesday, it will be in on Monday because I have my list of things to do and I just want to cross everything off on my list. And it is very much like that, you've got to do this, this, this and this. Your room's got to be tidy, it's very much like that. And I like that side, I do like that side.*

### **7.1.3 Belief Manifestation in practice**

This section of the preliminary interview provided insights into how Gary perceived his own teaching of the subject through his pedagogical approaches to mathematics teaching and how he managed WCIT phases as well as what a typical mathematics lesson might look like.

Learning Objectives and Success Criteria were greatly emphasised by Gary. He followed his school plan closely where the objectives produced by the strategy guided his decision making. For him the objective was the starting point from which he would move his class forward. The learning objectives and 'top tips' would always be on the board in every lesson, and when instructed by him, the class would look at the learning objective and come up with

*How are we going to know we've met it? What is it that we need to know? So, it's very measurable, ...It's the trick ...it's the little things, he explained so, if it's multiplying by ten or a hundred or something like that, it's that the numbers move, however many places. It's not you will learn how to such and such. It's very... (clicking his fingers), and if it's area and perimeter, it's area equals, multiple of two adjacent sides, things like that.*

Vocabulary was also an important emphasis which Gary related to the objectives and top tips. The example he gave of how he approaches teaching vocabulary was through teaching children skills.

*They'll do it, they'll practise it, they'll write it, they'll understand it, and they'll explain it and then they'll answer a word problem on it. Because if they can't answer the word problem on it, then you need to go right back to the beginning to find out, have you not explained your vocabulary correctly? What, in the word problem, did they not understand? because there must be something that's missing somewhere.*

Differentiation Gary believed was identifiable through seeing *that face* they sometimes give you that says *I really don't get it as I used to do it to get a bit of attention so when I spot those faces I give them a bit more time. I almost always start at the base level just to refresh their minds, start them off and then bring them up quickly. The first time obviously slowly to scaffold their learning just by quickly reminding them of the things that has gone before.*

Gary said he liked to play the clown, *have a bit of fun* with the children, *like me being silly falling over my chair*. He knew *it did not add anything to the children's achievement* not least because the other year five teacher taught formally and achieved similarly, but believed that his teaching *was much more relaxed, and therefore (placed)less pressure on the children*. However, when discussing pace and questioning, the evidence indicated that his belief that he was removing pressure for his children was misplaced. For example, all performance management observations, his head teacher commented that he was going *a little bit quick, a little bit too fast*. Yet despite this he remained convinced that the pace of this lessons should remain quick. He said

*my idea of my lesson would be, it's (clapping) de de de de de,(implying a face pace of steps) much more like that. Because I know that if I was sat there and I was (face of boredom) ugh, I would get so bored. ...I would much prefer, especially going into year five, what I'm teaching them is from level three to five, ...if they don't get it the first time, then I'm going to teach it again, probably in the summer term and they'll probably get it twice again in year six. So if they don't get it, no one's gonna die. Is it really that bad they don't get it?*

Consequently, his typical mathematics lesson would be *quite quick and pacey*. He said

*It will have a little bit of oral and mental at the start, which will always run over. Then you'd see a lot of success criteria, learning objectives, lot of partner talk and there'll be a lot of questioning, a lot of the use of the word why. Some use of ICT, Oh, there'll be resources, there'll be differentiation. He said he would have mixed ability pairings, because the group I've got there, from four A to three B, is exactly the same level of group I had last year in year six.*

#### **7.1.4              Summary**

To summarise, Gary's personal orientation towards mathematics he emphasised the following points:

- He found mathematics unproblematic through his schooling until he began his A' levels. He developed confidence in using mathematics in the work place and developed his knowledge of mathematics at university.
- He appeared to enjoy a methodical approach in working as a pupil, student, and as a teacher through the provision of structured frameworks.
- He appears to be driven by objectives, targets and levels with little to say about mathematical concepts, learning and education.
- He was influenced by his senior management team and seemed uncritically happy to be told what to do and how he should do it.

Finally, embedded in all the above were a number of pedagogical practices presented as elements of his day to day working. These included:

- **Connections:** Making links between clear, structured numeracy strategy planning with detailed learning objectives and 'top tips', and vocabulary. These would all be displayed on the class whiteboard and gone through with the children regularly throughout a week or unit of work.
- **Discussion:** Whole class teaching phases would be a variety of talking partners and teacher directed questions to individuals.
- **Explaining:** was not explicitly articulated, however, Gary described how he had a range of approaches in differentiation through explaining mathematics.
- **Questioning:** He emphasised that he 'trained' his class to ask good questions, how to be a good mathematics partner, and how to explain things clearly. He offered little in how he viewed the importance of his own questioning, but used it to differentiate in whole class activities.
- **Modelling:** Although Gary did not mention modelling in the manner in which other teachers referred to it, he emphasised the importance of remembering through regular memory exercises e.g. staring at your page and practise. He believed he was modelling good memory exercises with them so that they will continue these for themselves at home.
- **Resources:** Enjoyed the creative curriculum and the new outdoor mathematics resources for year 5 in the form of a 'play corner' in the classroom. Described as presenting mathematics through play. He also emphasised a regular use of ICT on the interactive white board.

- **Flexibility:** Little reference to flexibility in his mathematics lessons was mentioned. The emphasis was on familiar structured lessons; firstly mental exercises followed by a main section, with only a few investigations attempted each year.
- **Active maths:** Gary emphasised a use of physical movement in mathematics lessons to aid concentration of the children.

## 7.2 Overview of Mathematics in Practice

This second section presents a summary of the two or three lessons observed and then later discussed through stimulated recall interviews (SRI) to allow reflection. The presentation of this section has been separated into three categories:

- **mathematical intentions;**
- **pedagogical approaches used and**
- **classroom norms (behavioural approaches).**

Each category will list the characteristics of Gary's practice highlighted by the data. Each has been supported by examples of events consistently observed or comments consistently made by Gary providing evidence of the way in which Gary conceptualises his practice. Comments made by Gary are represented here in *italics*.

### 7.2.1 Mathematical Intent

**Prior knowledge** was activated through practicing exercises at the beginning of every lesson observed. Some were incidental e.g. waiting for the class change over, where the two classes (more able and less able children) would swap to go to their allotted set for their mathematics lesson. The activity seen in all three observations was practising a times table e.g. 6 and 7 times table written out in full as figure 7.1 illustrates below:

$$\text{e.g. } 1 \times 6 = 6$$

$$2 \times 6 = 12$$

Figure 7.1: example statement

Two of the three lessons observed showed Gary emphasising the practise of knowing the difference between odd and even numbers through a game called Popcorn where children stand if Gary shouts out an odd number, they sit if an even number. He explained this game was *to get the children moving* rather than to practice knowing what an odd and even number was.

Gary asked questions throughout the three lessons to activate prior knowledge for example in a lesson on data handling he asked: *How many ways can we collect data?* He asked them to discuss their ideas which he collected by choosing children to answer. The children responded with a range of ideas e.g. the US presidential elections and the x-factor.

In the final lesson video-taped after Christmas, the whole lesson was a revision. Gary went

*back to basics, because it was the first lesson I knew we needed to cover place value (PV), they've done it a million times but we wanted, to get right back to basics by putting the letters on the board for all the columns. This first lesson, my formative assessment I suppose of what their knowledge currently was. Had we done it a couple of days later, it would have been much better than the first day back.*

Gary's emphasis was to reactivate prior knowledge to inform him of what the children remembered, however the lesson sequence appeared to revolve around a focus on column headings and setting out for column addition rather than a focus on conceptual mathematical understanding.

**Vocabulary** was a consistent emphasis by Gary in every lesson observed. He did this through listing key vocabulary on the class white board next to the lists of learning objectives. These, as with the learning objectives, were ticked off when the class had looked at them in the lesson. He said *the vocabulary is just up there and so as we go through we can tick it off and say we understand it, and we can keep coming back to it* throughout the lesson.

**Formal written methods.** When asked to talk about mathematical concepts Gary talked much about the written methods of calculation. He made explicit connections between things like place value and column addition, in relation to the 'tests' which were constantly referred to in class. He did not distinguish between concepts and methods of approach to mathematics in interview. He gave examples of the importance of place value and a zero being in the *right place*, however the emphasis in the lessons observed were to instruct the children to draw grids and write the numbers underneath the correct headings like the example below (figure 7.2) of seventy one:

|   |   |   |   |
|---|---|---|---|
| H | T | U | . |
|   | 7 | 1 | . |

Figure 7.2: Place Value Grid

He talked to the children about the value of digits in relation to their column but his emphasis was on the setting out of columns rather than the knowledge and understanding of what each digit represented, which was observed to cause some uncertainty amongst the class. Another example of this uncertainty appeared in a lesson on multiplying by 10, 100 and 1000. He emphasised three key points when asking children to complete the activity: the number got bigger; the numbers moved to the left; and to use rainbow jumps. In SRI discussion he again emphasised a procedural method and mathematical understanding being one of the same. He was asked what if the children had come up with a decimal number when generating their own numbers to multiply by 10, he said *No, no I wanted them to think about what the answer was... the number got bigger, the numbers moved to the left of the decimal point, moved to the right or rainbow jumps. It was the TOP TIPS or for them to tell me what it was all about.* He added

*I would say I was leading them, if they'd done that number (3.7 was discussed in the interview) it was the actual words I was after rather than the number, some of them might have done that. But I wouldn't have thought that would have been the initial number they would have gone for.*

Gary continued

*I think the whole thing about multiplying by 10, 100 and 1000, is a very difficult concept to understand unless you have got a maths brain! And I think a lot of the time children will go through school literally knowing that you just move the numbers.... and they don't actually understand why they move the numbers, they don't know what they're doing but they just know multiply by 10, pick up and move one place to the left.*

He had recognised the difficulty once we had begun to discuss this further, but acknowledged he taught a procedural understanding because *not everyone has a maths brain.*

**Connections** to real-life were seen to be made explicitly in Gary's lessons but the connection seemed trivial. When discussing a lesson on handling data we talked about the choice of example. He asked the children *what is the colour of your front door?* Which he said he asked for quickness, where the children's hands could be counted and a table quickly recorded to be represented in a pictogram, which was his aim. On completing this task he reminded the children of a previous lesson where they voted for their favourite flavour of Walker's Crisps (a recent national survey), however, none of them remembered the event when asked to offer ideas of surveys. Instead they talked about the X-factor, US presidential

elections and favourite animals which they had seen on television. Gary then tried to prompt and guide the children to remember the school emphasis in science investigations *I wanted them to see, especially with data, how science and maths are so closely linked*. The children made no reference to this.

Although connections were attempted, the emphasis Gary generated was on ‘what’ data and the ‘how’ can we record the data, very little on ‘why’ data would be collected, which perhaps counteracts the point of making a connection with a real-life context? This was the first of a sequence of lessons on data, so he may have gone over this in another session later.

Another quasi-connection to real-life example was observed when teaching multiplying by 10. He asked one child if he multiplied 24.2 by 10 what number would he have. The child responded 24.20, to which he responded, *if he had 24.2 sweets and multiplied them by 10 how many would he have then ...24.20?* The children appeared to respond directly to the numbers involved, and not the real life example used. Gary explained later that *Oh, I just do sweets, chocolate, bananas, anything at random (real-life).... I don't know why sweets, add on a zero.* He seemed unaware of whether 24.2 sweets was a real-life context for children in the first instance.

What was observed to happen was that Gary *directed* connections through trivial questioning and not through the context of the task, e.g. When asking how to halve two numbers added together or find the middle number between two numbers, he asked ‘*what vocabulary matches up to what we've just done?*’. The children had been trained to refer to the board for an answer, either from the vocabulary or one of the other lists written there. He also saw mathematical *connections* as steps within a procedural process e.g. an algorithm. The example he used in one lesson was the question  $365 + 32 = ?$  (as illustrated in figure 7.3 below). He explained to the class the link between written methods and mental methods in calculating the answer. He asked the class *why might I use both methods?* to which one child answered it is ‘inverse’.

H T U

$$\begin{array}{r} & 3 & 6 & 5 \\ + & 3 & 2 \\ \hline & 3 & 2 \end{array}$$

Figure 7.3: column addition example

Gary explained *I was trying to scaffold the whole thing of getting this bit sorted, talk about the column addition and then add on John's bit as an extra (inverse).* Gary had a sense of progression when describing how *if you're finding half of a number the strategy you need is to add first, and then you halve so, we'd start off with making sure we can add two numbers together, and we have all the strategies for that.* He was insistent that everything was attempted in steps *building up to the knowledge and supporting the less able and just moving up and up and up*, he added *hopefully, extending the more able.*

**Memorising** mathematics was consistently referred to by Gary in class and in SRI. He believed memorising was a crucial skill for children in their cognitive development, and saw it as part of his role to provide ways in which children remember mathematical facts. One example of this was when he asked children to write out their six and seven times tables. When they had completed them he asked them to stare at the page to remember how they were set out and *stare and stare at them.* He said *that's how I was taught to remember them, it worked for me.* He saw memory to be related to ability levels which will be discussed in the next section on pedagogical approaches.

**Mathematics talk.** The final mathematical foci observed in Gary's practice was his reference to 'maths talk'. He mentioned 'maths talk' when describing a sequence of events where he asked children a string of questions but only one child was asked to respond.

He explained that his 'no hands up' policy meant that he asked a question to the whole class and expected them to all think about it, but would then choose who would answer. *That way the children have to think about it because I could ask them.* As classroom sequences unfolded, it appeared he consistently asked particular children for two reasons: 1) they were more able, he believed they would know the answer and he wanted to quicken the pace of the lesson. 2) Because he believed the chosen child was not concentrating, or talking; a behaviour strategy. These strategies are discussed in the class norms section later. Very little talk was seen, other than the teacher's question and one or two respondents, he explained *the strategies we talked about were: Place Value, column headings, zeros in to make sure all that sort of stuff. It was to do with the strategy I was after.* Again this appeared to be about method to *get the right answer*, and not mathematical talk or discussion in the development of children's mathematical ideas.

In sum, there appeared to be very little class discussion observed. There were times when the children were asked to discuss questions in pairs followed by a gathering of answers but this was teacher led where a particular answer was required. There appeared to be very little opportunity for children to ask questions, or develop their own ideas. Mathematical talk for Gary appeared to be two things: talking about a method, '*how to*'; and talking about '*what*' words meant. Mathematical talk was certainly an emphasis described and perceived by Gary to happen in WCI, however, it was constrained by the question asked and the time he provided for talk to take place. This category is therefore reported to be constrained mathematical talk, where the observation provided little evidence of what the literature describes as mathematical talk (as reported in the literature review).

To summarise these points, it was apparent that Gary had little to say about the children's mathematics learning and understanding, he emphasised a procedural or *Instrumental understanding* (Skemp, 1976) through each of the above features. Prior knowledge was activated by questioning, but the focus appeared to be on 'what' and 'how' to do mathematics, not to engage in the thinking and understanding of the concepts they were working with.

### **7.2.2 Pedagogical strategies used**

Gary talked a great deal about his pedagogical approaches in his initial interview which often resonated with his practice, however there were frequent contradictions and unexpected layers of complexities to these approaches which were found to be quite challenging to unpick and present here. This section is again presented through themes drawn from the individual case data coding.

**Resources:** Gary used resources, visual aids and images routinely in teaching mathematics. This mainly consisted of an interactive white board (IWB), a large class white board next to it, and a portable flip chart board which was located at the side of the room. The class white board was used to write up the learning objectives, the top tips and a list of vocabulary for each section of every lesson. This board was always full of these lists. The IWB was used for worked examples, written questions, and sometimes the children would be asked to write their answers. The remaining resources seen were number tubes to generate calculation questions in seatwork, different measuring equipment when looking at perimeter for a five minute slot in a practise session, and small white boards.

**Questions** were used extensively throughout his three lessons. He asked a variety of open and closed questions, where open questions were consistently related to the learning objective, the top tips or the vocabulary lists, although occasionally he asked a question like *think of appropriate questions to collect data*. Open questions he perceived as *tell me what you know about place value?* and direct this to a particular child. He also asked questions occasionally to recap the lesson so far, for example *what is that teaching us Tom?* Although in both cases it could be argued that these are not open questions because in his interview that followed the lesson, Gary would say that he *was looking for a particular answer*. Some questions were directed to pairs, for example *talk to your partner and explain what a perimeter is.* Gary explained that he asked lots of questions to check children's understanding of *what they were doing and how they should do it*. He explained that *most of the time the question will go to everyone, and with their talking maths partners, or you think on your own... And then if you don't put your hand up you'll be the one that gets picked.* Little paired discussion was observed in whole class phases, and although he claimed to have a 'no hands up policy' this method was used to gather questions at times.

Gary was observed to ask a string of closed questions regularly throughout all whole class phases of a lesson. He emphasised that he is always looking for the language and vocabulary. He expected the children to refer to the board for an answer in whole class phases, particularly if they could not remember what the aim of the lesson was about i.e. forgot what the learning objective was.

**Discussion** was not an emphasis observed in Gary's lessons contradicting his espoused beliefs in interview. There were occasional talking pairs, groups or whole class direction, for very short periods of time e.g. four seconds, but Gary believed discussion happened in whole class phases of mathematics lessons all the time. Children observed were expected to listen and follow his instructions, he stated that although he believed discussion was important he emphasised its use as a method of regaining children's focus and attention. During the SRIs we looked at the pattern of WCI phases together, which appeared to follow a sequence:

- i. Teacher questions class
- ii. Teacher asks individuals to answer this question.
- iii. If after three children could not answer correctly he offered the question to the whole class to discuss with their partners.

Gary said he thought that he may have believed it happened because he does it in other lessons throughout the day and had not thought about his mathematics lessons in particular.

This is an interesting response, as a primary teacher may not break the subject lessons up in their minds the way research may do.

**Lesson structure:** Learning Objectives and success criteria were a constant emphasis in all the lessons. Gary presented his class with a daily three-part lesson and followed a unit to unit (PNS) pattern. Lists of learning objectives were written on the board for both the 'mental' section (OMS) and the 'main' section on the class white board every day. At least two objectives were listed in the OMS and at least three in the main section. Most were covered through Gary's explanation then ticked off once they had been mentioned.

For example:

LOs:      **To half a whole number**      (*In red – Oral mental starter*)

**To find a middle number**

**To know perimeter is a measurement**      (*In blue- the main*)

**To find perimeters of simple shapes**

Top Tips:      **Use column addition/HTU**

**Half it then T then U then add**

**Mark where started counting**

**Use +/x**

Vocabulary: Perimeter, Area, Place value, Column addition, Column heading, distance

Gary explained that the learning objectives are colour coded on the board,

*the top tips, it's gotta be what strategy? So if it's something like dividing by 10, the top tip would be that (which) we use (like) the rainbow jumps that the number gets smaller, that the numbers move the decimal point stays, it's quite snappy things. It's not... you must do at least five of them or those sorts of things, it's a tip, it's the way that if you're gonna learn it, you need to know what strategy it is.*

Gary emphasised that he expected the children to refer back to the (information) board throughout the lesson. Sometimes he would explicitly refer to it or point to it to offer clues when he asked questions. He explained that

*when ...you are asking a question, you want them to give you an answer, half the time all they need to do then is look at the board, if they're struggling. And hopefully then and that's the same with the learning objective and success criteria, loads, of people come past, as in the management team ( there was a thorough through walk way in the classroom), and they'll just pick a child off and say, what is it you're learning today?*

Throughout the lessons observed Gary referred back to the top tips, which he explained was also an emphasis for him in Literacy lessons. *Yeah going back to it all the time, just to make sure that all the bits are there, because all those strategies and those points are there just to get the right answer.* Gary compared his approach with the mathematics coordinator in the school, he described her as being *very focussed on maths learning objectives and is doing three objectives in every lesson.* When Gary was asked if he could explain the pedagogical advantages of having this reference system in his classroom, he again reiterated it was for his SMT, however, he added

*I would want, in their minds eye, to know that on that board says the word pictogram. But if they haven't got that in their head then looking at the board they can see it. It's almost training them to look at that at the beginning of the lesson, look at it, look at it, yeah that's what we're gonna be doing, remember, remember, remember, and they shouldn't need to look back at that but it's there in case they need it.*

On one occasion Gary asked an individual to choose the next learning objective they would look at in a sequence of six in the main section that day, he said he occasionally asked the children to choose as *it makes them feel they are in control of their own learning.* Not all learning objectives were covered in this particular lesson as they spent longer on some than he had anticipated.

**Pace.** Gary emphasised his attention to a quick pace. He was aware (through management observations) that he would often talk very quickly and move a lesson on if he realised that he had let an episode go on too long. This was also regularly observed in filming, he altered pace and direction constantly, particularly in what he referred to as 'practise lessons'. These lessons were usually following a test that had been completed by the children the week before. Sometimes they were to *mop up* a range of concepts within a topic which the class had not performed as well as expected. Sometimes there appeared to be a wide variety of different concepts which reflected the type of test the children had completed. For example one lesson contained three different number concepts followed by a shape and space activity on perimeter.

**Practising** is a key emphasis in Gary's classroom where the message to the children was that practicing was essential when learning mathematics. He constantly referred to the 'tests', and provided tips and instructions in what *they will be looking for* (SATs markers). He was seen to contradict himself too in this message, saying he will not instruct the children

whether to do one method or another, yet he was seen to stop the class and tell them e.g. *this is a good way of presenting it* (referring to a child's white board who had drawn out grid columns of Th H T U and placed numbers carefully under the 'right' column title) *if you do it like this you will get the right answer and 'they' will see that you know column addition*, even though the learning intention was not column addition, but to add up four numbers. The observation, however, provided evidence that some of the children were able to mentally calculate this and write down the answer. There was no discussion about methods or strategies children used when they were practising mathematics, they simply did as they were told.

**Demonstration.** When asked to describe an episode, Gary said that he was *demonstrating modelling how to do them* (finding the middle number of two three digit numbers). He said *they needed to know and it consolidated so many things, it consolidated halving and everything.* On another occasion he demonstrated how worked examples should be presented by the children, his implication was that demonstration was part of his approach to review a method and teach them the *next step*. It was to *scaffold(ing) their learning, building onto what they already know, making sure they've got everything one hundred per cent before moving on.* When asked if demonstration was the same as modelling as he had used them interchangeably, he replied that *they are certainly similar. If I demonstrate something I show how to do it, whereas modelling is where you are doing something the correct way, the best practice.* His definition took some time as he had often used the words interchangeably.

**Modelling** he likened to *working though it as if it was my thoughts, like when we did the 6 (breaking down) splitting it down to 4 and 2. I was using my brain thoughts, very much like in literacy where you do your shared writing, where you demonstrate exactly what you're saying for the children to pick up. I think you probably do more modelling in literacy maybe. I think to demonstrate you are just doing it, whereas modelling would be where you are doing the best way of getting to it.*

**Explaining.** Gary did not emphasise *explaining* as a strategy in his mathematics teaching. He talked about how he got children to explain things to the class, however this appeared to be through strings of closed questions where individuals were 'picked' to *explain* different

steps or parts of worked examples. This followed an IRF<sup>2</sup> pattern, where little *explaining* by the children was observed, they were merely giving answers to specific questions. One might argue that if the answers were gathered together they would indeed explain a process of *how to...* or explain what *something* is... Explaining was not a pedagogical approach to the teaching of mathematics, as the observations revealed Gary only explained what the class were going to be doing and how they set it out. This could have been just bad luck in the selection of random lessons video-taped, but the observed focus appeared to emphasise a practice that highlighted the *what* and *how to* do mathematics, not *why* or *what if...* of mathematical concepts and thinking. The practice observed developed a sense of *this is what you need to know in year six for SATs, so this is how you do it.* When the children got things wrong in their fortnightly, half term, and full term testing regime, Gary explained over and over the elements the majority got wrong and practised them again and again.

**Mathematics is fun.** Gary often liked to play the clown in lessons, pretending to do or say something wrong. He enjoyed making the children laugh, e.g. he said

*a lot of the time I will say the wrong answer and expect them to hopefully try and tell me, and play the fool so they say no. no, no you're wrong! I believe it so strongly that they have the confidence in their answers that they will actually challenge me as a teacher.*

None of the observations provided evidence to support the belief that children would challenge him. However, he often played the fool, e.g. speaking in different voices, or saying funny things, joking with the children to make them laugh.

**Assessment** featured strongly in Gary's teaching approaches. He was observed to question individuals continuously as part of his WCI phase to check individual children's understanding. Summative assessment was as prominent in the practice through the comments made by Gary to the class as well as in the interviews after each session. He would remind children constantly of tests and markers expectations. He commented regularly '*they will be looking for...*' and '*they will expect you to...*' when he demonstrated or explained methods. Each week there was a regular test, often on times tables, and there was a regular end of unit test to assess levels on particular strands of the curriculum, e.g. Ma4 handling data. Gary planned with his colleague who taught the 'less able' group in year five. Gary did not have any classroom support in mathematics as he had the more able group,

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<sup>2</sup> IRF: Initiate Respond and Feedback (Sinclair & Coulard (1975) as explained in literature review.

however he referred to the groups of children as levels constantly. So he would often refer to his 'less able' children as his 3As.

**Concerns:** Gary often talked about his concerns regarding his teaching of mathematics. He believed he had to follow a very tight structure to his lesson, directed by his SMT. He said that he questioned very little about what he was asked to do, as he was very keen to do what was expected of him. However, the SRIs often revealed a dilemma and concern. On the one hand he wanted to do the right thing, on the other he stated that he felt this caused great pressure upon a teacher to perform to what he believed was the high expectations of the strategy documentation in the curriculum, his SMT and colleagues.

There were other concerns, such as the structure and volume of curriculum. He felt constrained by the number of learning objectives and the two weeks he had to complete the work. This together with the pressures of the school Christmas production, organisation and practise was also part of the enormous pressure he felt. He described how behind he was, *the data handling should actually have been last half term so already we're weeks behind. Also measures, we only spent a week on, but I could see we could spend months on measures. It's just like... (makes gestures of being breathless)*. He believed that if they had just two terms he would visit everything twice instead of three times. He said he felt

*constantly pressured, constantly hassled, feeling that you are not... (paused and laughed) this is like therapy.... feeling you are not doing the best for the children because you're rushing them through. You know their learning wants to go off in one direction, but you know if you go in that direction the lesson is gone. Tomorrow we've got singing and that's going to be short. I wanted to do an assembly group then I know I can't so.*

Assembly group was a catch-up class, for those children falling behind others in their class. He also had concerns about new pressures with using APP (Assessing Pupil Progress: DfES 2009) documentation where his school were demanding teachers assess all the class, unlike the guidance suggestion of a sample of six children. He said he knew

*that I'm going to have to move everyone two sub-levels at least. It's linked into performance management; you have got to move them two sub-levels. If you don't move them, you ain't a good teacher! If you don't move them they'll consider your pay rise!*

He was concerned about his 'target children' who had slipped behind last term.

These concerns were only some of those discussed in SRIs, but there is little room here to present them all. The key concerns here are analysed and discussed in-depth later in chapters nine and ten.

### 7.2.3 Classroom Norms

**Learning objectives and success criteria** appeared key to every lesson approach observed. The class white board displayed the comprehensive lists of learning objectives, top tips and vocabulary which Gary worked his way through methodically. This approach was perceived to be the expectation in this school in how they presented mathematics to children. An interesting observation was how this approach appeared to have developed very particular behaviour in the teacher and the children in WCI phases. For example, in one sequence of teacher questioning a particular boy answered the question *how could we represent this data?* Referring to a table of number totals on the board. The child chosen by the teacher was seen to look at the board and read down the vocabulary list and answered *tally*, which was the second word in the list. The numbers had already been totalled and so was not an appropriate answer, Gary took the answer and said *yes we could have tallied our numbers first then I would have added them up as we have here*. He then directed the question to another child who appeared to hesitate, but she too looked at the vocabulary list on the board and read the fourth word down '*pictogram*'. What appeared to have happened was that children have learnt that when they are asked a question the answer is on the board.

The lists on the board, Gary believed, to help 'train' the children to remember. He said

*I would want them to know that on that board says the word pictogram. That would be ideally, but if they haven't got that in their head then yeah, but looking at the board they can see that. And it's almost training them to look at that at the beginning of the lesson, look at it, look at it, remember, remember, remember, and they shouldn't need to look back at that but it's there in case they need it.*

**Whole class strategies:** Gary stated he was very aware of the strategies he used to focus children on their work, and on their thinking in WCI phases of a mathematics lesson. To sum the strategies he used consistently when observed were:

- He consistently targeted children when gathering answers to whole class questions.
- He believed it to help children focus if they were talking or he thought they were day dreaming. He targeted particular children, which he sat at the front of the room who

he needed to improve their levels in the next round of testing he did. He said he often *asked the quieter children, the less able children* to answer his questions.

- All WCI phases observed were a combination of teacher talk and teacher led activities. Short activities which built up a sequence of steps. He started at a low level and the whole class would work on activities at that level, then it would be increased quite quickly for seatwork.
- Teacher led questions were the norm, often a string of closed questions, occasionally open but always directed to target children. He occasionally opened his questions to others if the person he had chosen looked as though they could not answer, or ask some other question then go back to the first child, his saying was *coming back to you*, to warn the child.

Both teachers in this year group regularly tested the year group to gauge the level each individual was working. He appeared to know every child's level during filming, for he often stated that he chose a particular child to share their ideas because he wanted to see how they were doing e.g. *oh yes that boy came to me a 4a I haven't seen any evidence of that yet, so I am targeting him at the moment*. It appeared, to an outsider, that testing was an integral character of the way in which mathematics was taught in this year group.

**Active movement activities:** Gary believed it was important that the children had regular movement activities in lesson times to refocus the children and draw back attention. As already discussed the game 'Popcorn' was filmed on two occasions, one was planned as part of his focus on odds and even numbers, the other was impromptu. He said that *we would normally go out and do cross country first thing, just to get the children a bit active, getting a bit of energy and stuff go round*. After every mental starter, in every lesson observed, he asked the children to stand up and '*do this*', which he saw as a bit of fun as well as encouraging movement. It was similar to the game of 'Simon says' where the children had to copy what the teacher did every time he said '*do this*'. If he said '*do that*', the children were supposed to ignore it.

**Facial gestures** were an integral strategy of classroom management by Gary in his lessons. An example of this was where Gary was trying to draw an answer from a child who clearly was not sure of the answer he wanted. The class had been talking about data collection and

Gary was guiding the class to explicitly say that you first need a ‘question’ to collect data on. Some of the class had put their hands up, but as already described above, Gary chose the individual to answer. He said *Facially, it was the whole visual thing, my voice was also telling him... that's what you want and I was nodding my head and it was very, very blatant... and if you listen to the last ...well everyone else knew, it was what I was after. He was just being a bit of a 'dick' on that day!* He often referred to the children in this way which was meant kindly, he was clearly fond of the children in his class and talked very knowledgeable about each individual. He also used facial expressions to control behaviour from encouraging children to speak, get the ‘right’ answer (the one he was looking for), to stop talking, and pay attention. The children were observed to enjoy the amusing expressions he came up with.

**The pace** of his lessons were consistently fast as already discussed, Gary spoke quite fast and moved from one mathematical concept to another as already described in the pedagogical approaches previously, but he also moved from one question to another in strings, which the children had to follow.

### 7.3 Conclusion

Gary’s preliminary interview highlighted eight key mathematics teaching approaches as emblematic of his teaching practice. The observations and SRIs identified a broader set of strategies, some of which resonated with the original eight, some of which did not. Table (7.1) below summarises these strategies, framed by the three categories of practice as discussed above: Mathematical Intent, Pedagogical Approaches and Classroom Norms.

| Comparison between:                            | Espoused beliefs about his practice | Enacted practice |
|--|-------------------------------------|------------------|
| <b>Mathematical Intent</b>                     |                                     |                  |
| Making Connections                             | ✓                                   |                  |
| Prior Knowledge                                |                                     | ✓                |
| Vocabulary                                     |                                     | ✓                |
| Formal written mathematics                     |                                     | ✓                |
| Memorising                                     |                                     | ✓                |
| <b>Pedagogical Approaches</b>                  |                                     |                  |
| Use of Resources and images                    |                                     | ✓                |
| Questioning                                    | ✓                                   | ✓                |
| Learning Structure Learning objectives and top |                                     | ✓                |

|  |   |   |
|--|---|---|
| tips   |   |   |
| Quick Pace                                       |   | ✓ |
| Constrained Mathematics talk                     |   | ✓ |
| Flexibility                                      | ✓ |   |
| Explaining: Prompting & Telling                  | ✓ | ✓ |
| Discussion                                       | ✓ |   |
| Modelling  | ✓ | ✓ |
| Motivation: Active Movement to aid concentration | ✓ | ✓ |
| Practising                                       |   | ✓ |
| Demonstration                                    |   | ✓ |
| Fun  |   | ✓ |
| Assessment                                       |   | ✓ |
| Professional Concerns                            |   | ✓ |
| Classroom Norms                                  |   |   |
| Lesson Structure fixed                           |   | ✓ |
| Active mathematics Fun                           | ✓ | ✓ |
| Whole class procedures e.g. Performance targets  |   | ✓ |
| Facial gestures                                  |   | ✓ |
| Pace   |   | ✓ |

Table 7.1: Gary's espoused and enacted practice compared

The table (7.1) above illustrates there are indeed similarities and differences between Gary's espoused and enacted practices. The observations and SRIs, however, identified eighteen other emphases from Gary's practice which were not explicitly emphasised in the initial interview. Like Fiona, an interesting comparison between the espoused and the enacted is that Gary emphasises many of the structured organisational elements as key to learning mathematics in WCI e.g. the importance of learning objectives and top tips. What is also revealed is a strong difference between what he perceives as: discussion, making connections within mathematics or with real-life context in his WCI phase to what the literature and/or other teachers report.

This case provided enormous amounts of rich data, all of which could not be presented here, but each element reported upon here illustrates his attention to a range of methods and

didactic<sup>3</sup> strategies he perceived to be important in the presentation of mathematics. He clearly has many concerns about the constraints he feels he works under, and that he works very hard to do the ‘right thing’ in what is required of him. All the differences and similarities between Gary’s conceptions of practice and the other teachers will be discussed and analysed in chapters nine and ten later. Having presented the case of Gary, I will now move onto my final case of Ellie in the next chapter.

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<sup>3</sup> Definition of didactic used here is: intended to convey instruction and information as well as pleasure and entertainment, Encyclopaedia Britannica (online) as interpreted by an international audience, not in the sense of an English traditional one.

## **Chapter 8 The Case Study of Ellie**

The structure of the case study is presented here are in two parts, as described in chapter five, which help to highlight particular characteristics of each teacher's beliefs, attitude and teaching practices. Utterances made by the teacher are presented in all cases in *italics*.

### **8.1 Background: beliefs, attitudes and influences on teaching**

This first section provides a summary of the semi-structured interview at the start of the second phase of the study, and offers background information for teacher Ellie and the context in which she works. It is presented through three categories which detail elements of her beliefs, attitudes and preferences towards the teaching of a whole class phase of mathematics lessons.

#### **8.1.1 School Context**

Ellie was a year three-four mix class teacher in a small village primary school. She had been teaching at the school since achieving her BA QTS as a mathematics specialist, and was the numeracy coordinator. She had been a Leading Mathematics Teacher (LMT) over a year, selected by the county numeracy consultancy team. She was very happy at the school and enjoyed her role as an LMT. As the filming commenced she informed me that she was expecting her first baby, and so her commitment to the research project had to be flexible as she was not sure how long she would be able to teach for. We managed to complete the filming of two lessons and the respective interviews, we had arranged to film another one off session, but it became problematic with class Christmas performance commitments and her condition. Therefore only two lessons were observed and analysed. Although this might have proved to be problematic for the study, the observations and discussion with the teacher revealed much about her practice. The structure and delivery were similar in both cases, despite the different topics taught, and the children's reaction confirmed the procedures observed to be routine and regular, therefore I assumed these lessons were typical of Ellie's pedagogical approach to WCI phases of mathematics lessons.

#### **8.1.2 Belief Formation towards mathematics as a subject and as a teacher**

Ellie described her experience at primary school as very enjoyable. She enjoyed learning at this phase although did not elaborate on the point. She remembered she did very well in her studies at primary school and so

*I just felt I wanted to give something back, which sounds really cheesy.* She said she chose mathematics as her specialism on a primary BAQTS course, as maths was my

*favourite subject, and probably the subject I was best at. I just found it easier than other subjects. I enjoyed it more and I like a right or wrong answer, and I like thinking about why it's like that.*

She said that this enjoyment of mathematics had continued through her schooling, although she did not enjoy key stage three where the experience was *working through books and then checking the answers yourself and then going back and getting the next book. That wasn't particularly exciting but doing of the maths I enjoyed.*

Ellie described the influence of her family, her mother was not mathematical,

*my parents were divorced, so she was the homework help. And she really couldn't help that much with maths. My Granddad however, was an accountant, he was always (an important figure)...everybody looked up to him in the family, you know, he was a really nice man. And I think there was always that, oh, you're good at maths like your Granddad, and that's sort of quite nice, that feeling of being like him.*

She portrayed a sense of pride as she spoke about being like her granddad.

Ellie only referred once to her training as a mathematics specialist. She said how much she enjoyed training to be a teacher *once I started doing it, and I was on the course, there's a real thrill in children learning and you teaching them.*

As an experienced teacher she said

*I enjoy it when the children get it. You know, when there's those moments that they just understand. And I enjoy pushing children on, high achievers, they're really enthusiastic about it and they want to be moved on. I enjoy widening their experiences. She offered an example: there was a little boy and he really wanted a more formal method for subtraction. He'd got the way we were doing it, and the number line, he said (referring to the standard written method) he actually tried to work it out himself, so I showed him how it all worked and explained it to him in his book. Afterwards he put, thank you Mrs. French for showing me how to do subtraction like my Daddy does. And, you know, he was so excited because he'd tried. I like, when children try and work it out for themselves I think that's excellent.*

Ellie described influences to her teaching approaches, in particular the initial assessment approaches the local authority had developed with mathematics coordinators in her cluster group. She explained it was about *progressional planning, based on that initial assessment, using the primary framework.* The approach she described was that each child's understanding was assessed through *initial assessment for every unit, then move them on through the unit*, a method that she had disseminated through the whole school. She reflected how *we all (teachers) grow, don't we, it's inevitable in everything that we do*, she

said she often asked herself *why didn't I do that before? It seems so obvious now ... that's interesting*. She said she had *probably been teaching like this for about a year so I never have maths groups now. The children are in groups (which) are very fluid for each unit*, where children move between the groupings for every topic. Ellie believed grouping to be a problem in mathematics teaching in primary schools in general. She said children will *stick to that group* whether they need to or not which is then a problem for children. She inferred that this was to do with a child's confidence and attitude towards the subject. *She said I also think that teachers' own confidence in maths can be a problem, and I think that sometimes, maybe, they miss things out, or stick to a rigid scheme*. She passionately spoke about grouping in general, *I think that can then not necessarily always help the children, because it's either not very exciting or they're not getting the broad experience*. She said it was important to develop children's self-esteem in mathematics and although it is hard to locate what it is that a teacher needs to do, grouping children is an issue. She gave several examples of children she had taught the previous year and how motivated they became in mathematics when they left her class, because they no longer *felt useless at maths*.

She followed the framework, as her school policy instructed, however she had views on what the strategy did not offer children. For example she believed the framework offered very little geometry in mathematics. She said that children *get it quicker than the Strategy thinks that they will, especially shape, because they're interested*. You cannot say *you don't need to know about a parallelogram till you're in year five... You're telling them to find all the quadrilaterals in the box and then they say, well, what's this one called, you're not going to say, well, I'm not telling you that actually... You just have to give them time to research shapes and make shapes*.

To summarise, Ellie enjoyed teaching mathematics, and the children she taught. She was influenced by the local authority training which she received through the cluster school grouping and as a LMT. She enjoyed some aspects of the mathematics curriculum, but she also felt constrained by it to some extent, although she indicated that she would be led by her children's needs rather than the suggested planning guidance.

### 8.1.3 Belief Manifestation in practice

This section of the preliminary interview provided insights into how Ellie perceived his own teaching of the subject through his pedagogical approaches in general, but in mathematics in

particular and how he managed WCIT phases as well as what a typical mathematics lesson might look like.

Ellie spoke about how a recent training course on Shirley Clarke's (2003a) assessment for learning (AfL) where she was taught to *take the context out of the objectives, so everyone has the same objective, so we might be, "learning to recognise symmetry". That's what everybody's learning but the success criteria is slightly different, so one group might be drawing symmetrical patterns, another group might, be two axes for the symmetrical patterns, it's very progression*. She reiterated she would do initial assessment, often through questioning, to place children into groups

*usually I have at maximum of four groups. I always say to the children, "right, this is what you're going to be able to hopefully say by the end of the lesson, ...do you feel happy to do that?" and then they say, actually I'm not secure with that and they sometimes decide to go elsewhere, which is fine.*

She explained that the whole school take this approach, but individual teachers may have a slightly different interpretation, she said it depends *on their confidence with maths really.*

Her approach she believed to be an important aspect of teaching mathematics, *it's important that they have a broad experience of maths and do lots of different things.* She had much to say about the way in which she approaches her teaching, suggesting she had thought deeply about it. *I think the basics of number are crucial, and place value, everything builds on that. You're not going to reach every child and make them excited by maths but I think to have a moment, where something's really exciting, or something makes sense, I think that's really important.* The example she offered was *when you're doing an investigation, and children find their own way of finding a rule or pattern and then, they can't believe it that they can work out this, what the answer is for one million or something, those kinds of experiences where they're just really enthused (by it).*

Ellie emphasised how hard she finds whole class interactive phases of mathematics lessons. *I prefer, when I have my Higher Level Teaching Assistant (HLTA), to have her teaching a group because I think whole class teaching is very difficult to reach everybody.* She said *I do lots of modelling using lots of mathematical vocabulary. I do pair talk, so that they can talk, when it's the whole class they get to talk to different children with different experiences.* Which she believed was beneficial. Although she initially talked about modelling to 'show' the children how to work out questions with no pupil input, she then proceeded to talk about how she

involved the children to talk about what they had seen and share other methods or strategies to work the example out. Discussion she believed to be important *everybody* (then gets) *a chance to talk* about their ideas.

Ellie believed that part of the difficulty with whole class teaching is *for the more able children they, if they're talking to a partner, they are having to explain their method, so that's quite hard to do*. She went on *for the lower ability children, it gives them a broader experience than if they were just being taught with children who were at the same level as them, they wouldn't see, ever see any of the harder things that they might actually grasp*. She emphasised how important for all abilities to be working together and discussing their ideas together in this way.

Ellie said she *still follows a three part lesson* although she implied that it was not stuck to rigidly. She believed her support staff, a HLTA and another assistant, were a great asset to have in her classroom in all mathematics lessons. She would use them to take mini starters with small groups and talk to individuals about misconceptions.

#### 8.1.4 Summary

To summarise Ellie's personal orientation towards mathematics she emphasised the following points:

1. She found the subject of mathematics most enjoyable at school
2. She remembers strongly a dislike of a mechanistic approach at secondary school where she had to work through books and worksheets
3. She believed the new approaches to teaching mathematics were much better she emphasised a clear and structured approach to her planning and teaching of mathematics
4. She was influenced by the local authority strategy team in how she approached teaching, but was concerned that not all teachers were confident in the subject to give a broad experience

Finally, embedded in all the above were a number of pedagogical practices presented as elements of her day to day working. These included:

1. **Connections:** Ellie did not explicitly talk about making mathematical connections for or with children in her interview. She did talk about the children talking about their

methods and strategies however, which implied that she expected the children to make their own connections about ‘how to’ do mathematics, either with their teacher or with each other.

2. **Discussions:** Ellie talked much about the importance of children talking with each other and as a whole class with her about methods, strategies, vocabulary and concepts.
3. **Explaining:** Ellie emphasised several elements to her approach in teaching mathematics. She did not explicitly talk about how she liked to explain things, but the emphasis was on children explaining concepts, their ideas, their methods and strategies.
4. **Questioning:** Although Ellie did not emphasise this explicitly as an approach, she mentioned it often as part of her assessment of children’s engagement, knowledge and understanding of mathematics in what they were learning about.
5. **Modelling:** Ellie talked about modelling to ‘show’ children how to do something e.g. calculate using a number line where the children would watch and listen. However, she also talked about modelling as an approach which involved the children in discussing and showing other methods and strategies they know or used. This may indicate that she was not altogether clear on what she understood modelling to be.
6. **Resources:** Ellie emphasised a passion for good resources. As coordinator in the school she talked about making up topic boxes for the staff to access which would contain a variety of resources that might encourage them to use. She believed colleagues were often set in their ways of working and only used particular resources occasionally.
7. **Flexibility:** Ellie did not talk about her approaches as flexible, but talked about her flexible use of other adults in the classroom. She welcomed support from the HLTA and other teaching assistants, and would use them to teach different groups at different times depending on what they were doing.
8. **Confidence and Attitude:** Ellie talked much about developing good learning experiences for children to encourage confidence and positive attitudes towards

learning mathematics. She emphasised her use of reviews or plenaries as a technique to develop confidence and self-efficacy in children. Emotional wellbeing was an important consideration to Ellie in mathematics lessons, she emphasised that her lessons were always clear and structured so that children knew what to expect, but they were also expected to participate in every aspect. Thinking, discussion with a partner, with their group and have an understanding of what they were learning.

## 8.2 Overview of Mathematics in Practice

This second section presents a summary of the two or three lessons observed and then later discussed through stimulated recall interviews (SRI) to allow reflection. The presentation of this section has been separated into three categories:

- **mathematical intention;**
- **pedagogical approaches used and**
- **classroom norms (behavioural approaches).**

Each category will list the characteristics of Ellie's practice highlighted by the data. Each has been supported by examples of events consistently observed or comments consistently made by Ellie providing evidence of the way in which Ellie conceptualises her practice. Comments made by Ellie are represented here in italics.

### 8.2.1 Mathematical Intent

**Prior knowledge** was emphasised by Ellie as a method to inform and develop new knowledge. She was observed to do this through a number of strategies in practice. When teaching shape and space, for example, she and the children developed their own dictionary of shape words and definitions as sessions on the topic progressed. She referred to this list (through a power point slide) at the beginning of each lesson to remind them. A paired game was another strategy the children were used to, they were expected to use their prior knowledge to play the game either to solve a problem or compete against their partner. The children were seen to both enjoy and engage in this type of activity most eagerly.

**Mathematical Reasoning:** Ellie was seen to make use of children's ideas regularly in observations through encouraging discussion with talk partners and whole class. She encouraged children to publically discuss what they know, share ideas and reason. For example she encouraged a child to show the class what shape he had spotted on the image she had shown on the board, like the one shown here (fig 8.1).

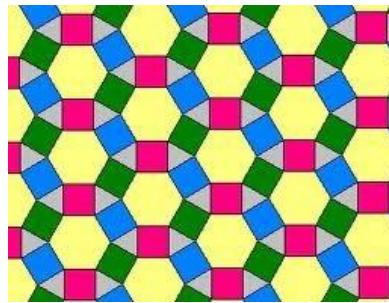


Figure 8.1: Tessellation example

After initial discussion in talk partners children had identified the hexagon, equilateral triangle and the square. Ellie asked one child to show the class, he had spotted a bigger shape where he had visualised several shapes joined together to make a new shape. He described a twelve sided shape the dodecagon. She reminded the children how they had discovered a dodecahedron when they were looking at 3-D shapes earlier in the week, and Adam had looked it up in a class mathematics dictionary to find out the correct name. The children responded enthusiastically to this idea and began to look differently at the tessellation. This appeared to develop other children's ideas and perceptions of how to look at a tessellation a little deeper. As a consequence, the class began to notice other shapes, not only from joining shapes together to construct irregular polygons, but also they began to look at the edges of the slide which showed sliced regular polygons. This episode appeared to develop the children's ideas greatly as they then spent longer on this tessellation than Ellie had planned. Adam for example spotted a trapezium and again he showed the class where on the tessellation. Many other shapes were then spotted, but one particular interesting observation was from another boy who explained to the class he had spotted '*a triangle that has been cut*' and said that it was a '*truncated triangle*'. Ellie explained that it was like the 3-D shape he had looked up in a previous lesson. The particular boy had been looking at some 3-D shapes and spotted the cut cone and wanted to know what this was called. As this image shows (Fig 8.2) below:



Figure 8.2: Frustum cone example

Ellie explained that *we've got these wooden shapes, we'd got free, they are so random. I mean they're good shapes, there's like an egg in there, and there's the cone with the top cut off and some of the boys were saying 'well what's this?' and this particular boy looked it up...*

*and then because we've got the polydron, a lot of the big polydron shapes are called truncated if they've got the corners cut off. So they just think that anything with a bit cut off can be called truncated.* She was clearly pleased with this discovery and the boy's reasoning in trying to apply his understanding logically to this 2-D shape. There were several other examples in this episode where the children were clearly enthused and keen to share their ideas with the class, so much so, that Ellie had to stop the discussion and ask children to write down the shapes they had spotted on post-its and stick them on the board so that they could all look at them later at the end of the lesson. The observation illustrated that Ellie encouraged opportunities for children to reason, offering their ideas and to talk about what they know, and confident enough to ask questions. There was an explicit period of time at the beginning of every lesson by Ellie where the children displayed that they were very used to this discursive approach.

**Vocabulary:** The emphasis on mathematical vocabulary was seen to be an integral part of Ellie's lessons. For example she consistently emphasised key mathematical vocabulary through three approaches: 1) introduce them at the beginning of every lesson through paired talk and teaching; 2) she explicitly encouraged children's use of specific vocabulary through playing games in the OMS; 3) when new words cropped up in whole class discussion she would write the words on the board, later adding them to the class topic dictionary.

The paired games, as already mentioned, were a strategy for Ellie to model how the mathematical vocabulary should be used in order to play and win the game, if appropriate. She 'modelled' playing the specific game with a child to show the way in which she expected them to think and question each other i.e. mathematically. She said she found this method of using the vocabulary very successful, as the children began to use it outside the lesson as they began to become familiar with it.

**Mathematical tasks:** An emphasis on the choice of task was an approach Ellie described frequently when discussing her observed activities in SRI. For example, she spoke about the use of her tessellation picture (as described and illustrated above) how she *used pictures from the internet* and found that the children were able to draw much more from them than anticipated. Ellie liked to use interesting resources and tasks that had more open ended opportunities. *I like it (using pictures) because it's really open ended. And they seem really keen to find really tricky shapes.* In another lesson, Ellie displayed a grid of different times (analogue and digital-including the twenty-four hour clock). The class had worked on

analogue clock and she had moved some groups of children onto digital but wanted all to see what digital times might look like and *why* they were displayed as they were. This will be discussed later.

Ellie's school subscribed to a computer resource called 'Mathletics'. This was a piece of software which allowed children, and families, to use inside and outside of school. Homework was often given that involved the children logging onto the school website and link to this mathematics program. The children appeared to enjoy it and recognised the games and levels. However, the levels appeared to develop rapidly. E.g. time differences which began with times that could be calculated in their head, but after the first two questions children needed a strategy to support their thinking.

### **8.2.2 Pedagogical Approaches**

Ellie emphasised her pedagogical approaches in her initial interview, however, many more were revealed through the observation of her lessons. This section is again presented through themes drawn from the individual case data coding.

**Questioning:** Ellie used many types of questions throughout whole class teaching phases. She would ask children to name the shapes displayed on the board for example, but asked what they could tell everyone about that shape they could name. This type of question could perhaps be referred to as a probing question as described by Houssart & Weller (1999) and the NNS (DfEE, 2002). For example when a child announced that all the shapes on the board were polygons she asked that child to define what a polygon was, and discussed this with the rest of the class. This appeared to draw from the children what they knew about shape properties and taught others who had not spotted shapes others had. I am not convinced that Ellie was able to articulate this idea in the interview that followed the lesson, but the filmed episode provides interesting evidence of using questions to build on other questions. For example, when a child said that the shape she had spotted in the tessellation was a '*diamond*' Ellie asked the child *what is the difference between a diamond and a square?* which challenged the child's idea of a square and its orientation, which she recognised after a while (Ellie gave her time to think about it) and exclaimed *oh, it's a square moved round a bit!* Ellie agreed the shape in question is a square, but oriented 45°.

Another example in a lesson on time, the board displayed a grid, she asked the children *What can you see on the screen?* The children were instructed to talk about this in their talk

partners, she said of the episode *I didn't want to lead them in any way. I just wanted them to tell me anything they could about what they could see. The learning objective was displayed above my head, but I didn't say it straight away because some of the children were able to remember.* The choice to emphasise this episode as a question relates to Ellie's emphasis of using key questions in WCI which was a regular occurrence. In fact the repeated enactment of this emphasis was seen to be a classroom norm which is described in classroom norms presented later in this section.

**Progression and differentiation** (LOs and SC): The way in which Ellie approached mathematics lessons appeared to be very structured on one hand, yet there was flexibility in her differentiation. She always had groups (ability) but these changed with every new concept taught. She always carried out an initial assessment (as indicated earlier) on children's knowledge, and then placed the children into groups. This will also be discussed further in the next section on classroom norms.

Learning objectives were an emphasis in Ellie's approach to learning progression. She said *when it's the first lesson I would normally write it up and we'd pull it all apart. Looking at all the words and what they mean and what exactly that is and then... because the learning objective will stay the same for a period of a few lessons, maybe even a week, and because the context is taken out e.g. we are learning to measure time. It doesn't matter what they are doing, they are still learning to measure time so then the next successive lesson I would expect that the children would be able to tell me.* This was seen to be the practice. The lesson on shape observed saw Ellie write the objective as: *We are learning about shape.* The children were placed into differentiated groups where their outcomes (the success criteria) were slightly different for each of those groups e.g. to know the difference between regular and irregular shapes; to identify the properties of regular polygons; or to find the lines of symmetry in 2-D shapes. It was not listed on her board in this way – only in her planning – but she expected the children to know this.

**Discussion:** was a significant pedagogic emphasis of Ellie's mathematics' lessons. Children were expected to discuss questions with their talk partner and/or publically with the whole class when instructed. The talk partners changed every three weeks and were mixed ability pairings, this was a whole school initiative in all subjects. Ellie was not convinced all teachers used the talk partners in the same way, but she had found it very effective. She believed the

children were happier and more involved with their learning than they ever had been previously.

There were several mathematical intentions why Ellie used talk partners as an approach, such as reactivating prior knowledge, as already discussed earlier, but also the development of new knowledge and understanding was also observed through talk partners e.g. the example explained earlier when the class was looking at a picture of a tessellation. The paired discussion went on for several minutes before she called the class together to discuss their ideas, but the whole class discussion went on for a further twelve minutes. This emphasis appeared to be a typical occurrence, where children were encouraged to talk and ask questions about what they were thinking, and were afforded the time in which to do this. Misconceptions were also revealed in this approach but time needed to be given for those things to emerge she explained. She added *I don't have many problems with them not being on task* but she would instruct the children by saying: *I'm going to choose a pair to talk about it*, to encourage them to stay on task. She was observed to listen in and sometimes join in paired talk, where she moved around the carpet area. She said this provided her with an overview of the language used and indicated further grouping choices in seatwork. On calling a halt to the paired talk, she often chose not to be the 'explainer' herself, instead she preferred to use the children to do this.

**Communicating mathematical vocabulary and practice:** This pedagogical emphasis was a consistent element of observed lessons. Ellie encouraged the children to use mathematical vocabulary through a number of approaches as follows:

- Explicitly demonstrated the use of the vocabulary throughout the lesson;
- Modelled the use of mathematical vocabulary through reorganising children's sentences and responses to her questions;
- The games played or tasks in pairs where good communication was emphasised;
- questions she asked the children to talk about in pairs; and
- at the end of each lesson, she would ask individuals (one from each of the groupings) to explain to the class what they had been learning that day, there was a high expectation of the language the children used to describe their learning.

When reflecting upon a game introduced in a lesson she said *I think I was fairly pleased for the first go at that activity, there was definitely the vocabulary being used by the children,*

*not as widely as it could have been but when I did it the week after filming they were even better at using the vocabulary.* This discussion identified Ellie's attention to encouraging the children to use mathematical vocabulary in a context together.

**Demonstration:** Ellie often talked about demonstrating to children, but when questioned on what she meant by it as an approach, she would revert to the episode as modelling a way of working. She was certainly observed to demonstrate the use of number lines to individuals in WCI phases, but it was not publically, it was in their pairings for example; so little was seen.

**Modelling:** Ellie said she often used games to begin a lesson regularly and the two observed bore this out. She said she introduced a variety of new games throughout the term so the children continued their interest. As already alluded to earlier, when introducing a new game she will model the rules and tactics by playing the game with a child, to show the class how to play. She explained that when she is modelling she is *showing how to play the game successfully. I suppose modelling (therefore) would be really modelling how to play the game and modelling how to play the game well.* She wanted them to use *the vocabulary* related to the mathematics they were learning within a context. Ellie said the games would begin as ideas but they developed *on the job*. She admitted she did not always think everything through some things came to her *in the moment* in a lesson.

**Mathematics is fun:** Ellie talked about how she used games not only to develop mathematical learning but also for fun. She said *I always tend to look for the game in things really, because it's fun for them, they enjoy it more when they think it's a game.* She explained how in one observed lesson she developed a new game as she was providing instructions for the children to play. E.g. the grid of time shown on the board, she said *well I looked at it and thought ooh I could make this into a 'four in a row', five in a row in this case, to make it more challenging.* Ellie talked about how games were always developing and emerging from activities in lessons, she believed the children responded very well to them and consequently enjoyed *doing the maths.*

**Assessment:** As stated earlier, Ellie said she always began a new topic with an initial assessment to gauge where the children were so that she could group them in the following session. Groups were flexible and changed regularly sometimes daily. Ellie described how she used the end of a lesson to encourage individuals to talk about what they had 'learnt' in

the lesson and what they believed they might be learning next. She said *I want them to know that they need to know. I'm not going to sit there and tell them every time, or they will never be able to say what they're learning, this way they know*, and they know what's coming next.

She found this discussion difficult in the SRI, as she said she had probably not thought about this so deeply before. However, *I think it's just making them responsible for what they are doing, if they don't know what they are learning, they just think of the activity, they go to lunch and the next day it's gone. Whereas here they have to think well if I do this today, yesterday I could do that, tomorrow I can do this.* She believed *the children can see their achievement I suppose*. She implied that she consistently assessed the children but very much in an informal manner daily. She did not talk about tests other than at the end of the year but could describe what each child was capable of and what and how she would progress that individual's learning forward.

To summarise this section, it was clear from the observations that the children were very much involved in the WCI phases of mathematics lessons. These phases were dominated by discussion between the children, facilitated by Ellie, where **questions, enquiry and curiosity** were seen to be valued and encouraged. What was most interesting, from an observer's point of view, was that many of the approaches were made instinctively, as Ellie was not always able to articulate her approach. She chose interesting activities that all children could engage in, but could only say that she thought it would be good and not always why mathematically.

### 8.2.3 Classroom Norms

**Children's confidence and attitude:** Ellie was seen to emphasise building mathematical confidence in the WCI phase of lessons through paired and whole class discussion. She often encouraged those that wanted to share their ideas and knowledge with the class to do so, but also she encouraged all children to ask questions and learn from looking things up in a dictionary or from each other. The key WCI norms that emerged have already been discussed earlier in the MI or PA sections of the case, however to provide an overview of what were reported to be a consistent pattern throughout each lesson observed and emphasised by Ellie are as follows:

- Children were expected to talk, using well defined speaking and listening rules e.g. sharing, taking turns to speak etc.

- Children were expected to try out new vocabulary in their discussions with each other and whole class discussions.
- She consistently gave the children a whole minute to discuss each question.
- Ellie listened out for misconceptions, confusions and questions whilst the paired talk took place, e.g. confusion occurred with one pairing who did not understand the difference between ‘vertex’ and vertices’. If the pairing had discussed anything with her she expected the pair to explain this to the class at the end of the paired talk.
- She was particularly sensitive to how she grouped children to differentiate the work. Whole class activities were seen to be aimed at the middle to top levels.
- At the end of each session she expected children to know what the next ‘challenge’ would be for their group the next session.
- Ellie encouraged the children to ask questions in whole class teaching phases. One child questioned her instruction relating to a game on time where there was a grid of mixed digital and analogue words and figures. He questioned her instructing the children to challenge talking partners to the nearest minute. The boy asked *if it is to the nearest minute, why have you got O'clock and half past times on the grid?* Ellie explained in the interview that she welcomed that sort of challenge as it demonstrated that that child had noticed that we round things when using analogue which sparked a discussion off between the class about rounding time readings in analogue.

**Flexibility:** Ellie spoke about how flexible her control was on discussion, she often let discussions go on for some time if she believed the discussion was purposeful. For example the lesson on shape, presented earlier, she said *the talk did go on for longer than I expected, because (well) that's alright, I think the lesson was fine*. She was amused that one boy had corrected her about an irregular shape name, *well does that matter? Why would I know that? And I think there are always times like that every now and again. I don't think you are a very good teacher if you don't reflect on it. It doesn't always go well, and I know I don't know everything. I will just probably do it differently next time*. She mentioned several times in SRIs that she reflected on what happened in a lesson, which she believed, developed her pedagogical approaches to mathematical tasks. She appeared confident in her belief that a good teacher was flexible and was constantly learning.

Timing was not an issue for Ellie, she often explained that she was confident enough to be flexible in her pace and progression of a planned lesson. She said

*I don't think it matters at all, I think if most of the children are engaged and they were interested I would carry on. She said obviously they had more to say, about the tessellation filmed, and that's why I said at the end, if you've got something else to say, put it on a post-it note. She said we sat down after lunch, when you had gone, and we ripped the post-it notes off and talked about what everyone else wanted to say. So I think it's important several children got something out of that, it was worth it! She believed it's really letting the children know they've found out this really good stuff, like the truncated cone.*

She said it was *all relevant*, she believed it to encourage children's confidence and attitude to learning mathematics where the children made connections for themselves.

**Games:** as already discussed in the pedagogical approaches, Ellie believed games developed children's enjoyment and confidence in using mathematical vocabulary. The point to emphasise here is that Ellie used games, made up or otherwise, like a spring board from which to encourage and develop children's use of vocabulary. As already highlighted, she explained that the children enjoyed the challenge of games and they provided a *challenge for all the children*, not just *the more able*. Every child was involved and was required to think and talk mathematically, she said *they want to be challenged and be challenging (each other) don't they!*

**Thinking and communication:** Ellie emphasised her deliberate use of appropriate periods of time for children to think and communicate in and outside mathematics lessons. There was a clear sense of expectation on the part of Ellie that the children were required to think for themselves and with their paired partner, as well as a whole class through good communication skills. These emphases have already been discussed, but the significant characteristic here was the way in which mathematical thinking was at the heart of the exercise, not just the speaking and listening skills e.g. take turns to speak and learn to listen. Indeed Ellie's conception of the events illustrated that the task of talking in pairs and the expectation of how to discuss a question, e.g. use correct vocabulary, ask each other questions etc., and importantly, she provided the time necessary for the children to achieve these goals. There were also very explicit moments in filming where Ellie would insist on 'NO HANDS' when she wanted the children to think for a time before she was ready to accept their ideas. The children behaved as though they were accustomed to this way of working and therefore it was assumed that this was indeed a classroom norm.

Games, as already discussed, were integral to developing paired talk and purposeful thinking time. Children were keen to *win* the game they were playing, but it appeared to be an enjoyable experience for the children rather than a divisive one. It could be argued that the children saw a purpose in the game e.g. winning it, which involved strategies and risks, rather than an exercise to practise their mathematical knowledge.

The children were enthused and eager to learn, constantly asking questions and wanting to know more. One explicit emphasis by Ellie, was the high expectation she had of some of the children in the class, where their enthusiasm and curiosity were encouraged and shared with the class. Not planned, such as the incident of a boy looking up truncated shapes in a dictionary, these happened in the moment of WCI phases, which could perhaps never be planned for. The classroom norm here is perhaps how a teacher uses impromptu opportunities to develop mathematical thinking, both in an individual and the whole class.

**Autonomy:** although this category does not fit into any of the three themes above, it was a characteristic believed to be worthy of mention here. Autonomy is was not something Ellie discussed, but the observations and the implications of what she said, emphasised a level of great confidence in not only how she presented mathematics to her class, but also her rationale for those actions. She appeared to take great care in selecting tasks and activities that would appeal to her class and engage them all, whatever the level the children were working at. Sometimes this conflicted with the PNS guidance, but she did not worry about that as she was confident in her approach which was clearly reinforced by her role as a leading mathematics teacher in the county.

### 8.3 Conclusion

Ellie's preliminary interview highlighted eight key mathematics teaching approaches as emblematic of her teaching practice. The observations and SRIs identified a broader set of strategies, some of which resonated with the original eight, some of which did not. Table (8.1) below summarises these strategies, framed by the three categories of practice as discussed above: Mathematical Intent, Pedagogical Approaches and Classroom Norms.

| Comparison between:                                | Espoused beliefs<br>about her<br>practice | Enacted practice     |
|--|---|----------------------|
| <b>Mathematical Intent</b>                         |   |                      |
| Making Connections                                 | ✓   | ✓<br>(implicit only) |
| Prior Knowledge                                    |   | ✓                    |
| Mathematical Reasoning                             |   | ✓                    |
| Vocabulary   |   | ✓                    |
| Mathematical tasks                                 |   | ✓                    |
| <b>Pedagogical Approaches</b>                      |   |                      |
| Discussion   | ✓   | ✓                    |
| Explaining   | ✓   |                      |
| Modelling  | ✓   | ✓                    |
| Demonstration                                      |   | ✓                    |
| Questioning  | ✓   |                      |
| Resources and visual aids                          | ✓   | ✓                    |
| Progression and differentiation                    |   | ✓                    |
| Communicating mathematical vocabulary and practice |   | ✓                    |
| Fun  |   | ✓                    |
| Assessment   |   | ✓                    |
| <b>Classroom Norms</b>                             |   |                      |
| Flexibility  | ✓   | ✓                    |
| Confidence and Attitude                            | ✓   | ✓                    |
| Games  |   | ✓                    |
| Thinking and communication                         |   | ✓                    |

Table 8.1: Ellie's espoused and enacted practice compared

The table above illustrates there are indeed similarities and differences between Ellie's espoused and enacted practices. The observations and SRIs, however, identified eleven other emphases from Ellie's practice which were not explicitly emphasised in the initial interview. The MI revealed in practice did not support explicit mathematical connections made by Ellie, but these were seen to develop in her encouragement of mathematical reasoning, her choice of task and the high expectation of purposeful talk. These elements will be explored further in chapter six. Another surprising outcome in this table is that her questioning was emphasised in the original interview, but not developed explicitly in the observation or SRI. The reason for this is that the questioning came through various channels, e.g. her attention to whole class and paired discussion. Questions were asked

continuously, but not always by her, they were also asked by the children. This provides a different slant to the overview of questioning in this case compared to some of the others, as Ellie's emphasis was on children's engagement through a very strong expectation of communication and reasoning.

The final point to make in this case is the autonomy displayed by Ellie in her decision making in WCI phases. This will be touched upon in chapter nine but will be explored more deeply in chapter ten. Having presented the four cases, I will now move onto the case discussion in the next chapter.

## **Chapter 9 Discussion of the phase two teachers**

### **Chapter Overview**

Each of the cases presented in chapters 5 - 8 comprised two parts. The first, prefaced by an examination of each teacher's educational life history, addressed colleagues' perspectives on mathematics, mathematics teaching and the organisation of mathematics classrooms. The second reported on observed practice in relation to teachers' espoused actions and their justifications. The following is a similarly structured report about the four phase two teachers.

#### **9.1. PART 1: Teachers' espoused perspectives on mathematics and its teaching**

In the following I discuss the backgrounds of the project teachers and how these have informed their beliefs about mathematics and its teaching. It is presented against the three broad headings that structured the interview analyses. These concern the following:

1. Mathematics as a subject
2. Mathematics knowledge for teaching
3. Being a teacher of mathematics

##### **9.1.1 Mathematics as a subject**

All four teachers, enjoyed mathematics as a child at school, particularly at the primary level, from which they remember the subject fondly. For Caz and Ellie much of this enjoyment stemmed from a family tradition in which mathematics was challenging but interesting. For example, Caz spoke of working on and discussing interesting logic puzzles with her brother and father. Ellie remembers how everyone looked up to her grandfather, who was good with numbers, and how, according to 'family folk-lore', she was just like him. They were proud of what was to them as children the normal family behaviour. Moreover, both spoke of being members of mathematical communities, in the first instance as family members and in the second as successful learners of school mathematics. Such experiences seem to have shaped their identities not only because experience underpins and reinforces, modifies and extends who one is (Bohl and van Zoest, 2002) but also identifies them within a 'special' or 'mathematical' community (Wenger, 1998). These perspectives permeated their beliefs about teaching. They spoke of wanting their students to not only enjoy mathematics but also be members of a classroom mathematical community. They spoke of their students cooperating, communicating and negotiating their thinking and ideas in an appropriately

supportive environment. Such hopes resonate with research into effective teaching and learning. For example, Malaguzzi (1998) writes of the environment being the ‘third teacher’ in early children’s learning, while Boaler & Greeno (2000) and Cummins (1996) discuss the importance of understanding one’s relationship with the world in which one operates.

Similar themes, though expressed differently, emerged from the interviews with Fiona and Gary. In relation to their early experiences of mathematics, they both remembered how they had enjoyed working through various procedures and calculations, achieving accurate work ticked by their teachers. They talked about this with some pride, implying that these successes were important to them and demonstrative of their achievement and self-efficacy as young learners of the subject. In this way it can be seen how their beliefs about the nature of mathematics as instrumental arose from their own experience and enjoyment and, ultimately, their identities as teachers focused on skill mastery and passive reception of knowledge (Ernest, 1989) that is, content focused with an emphasis on performance (van Zoest et al., 1994). Such emphases differed from those of Caz and Ellie, who located their talking about skill mastery and development of knowledge alongside the development of student understanding.

In sum, these early experiences may offer an explanation as to why these two pairs of teachers talk similarly about their teaching. Caz and Ellie both talked about sharing with their class their enjoyment of, interest in and relationships with mathematics as a subject, whereas Gary and Fiona talk about sharing mathematical targets and achievement levels in a fun way. Such findings echo research, highlighting not only how practice-related beliefs are informed by teachers’ belief systems about the nature of mathematics (Ernest, 1989) but also how those beliefs themselves are located in early learning experiences (Pajares, 1992).

### **9.1.2 Mathematical knowledge for teaching**

There is substantial evidence in the literature relating to the need for teachers of mathematics to hold appropriate and deep mathematical knowledge, an issue more for English-speaking teachers than, say, culturally Chinese teachers (Ma, 1999). In the following I discuss the four project teachers in relation to their background and confidence in their mathematical knowledge.

All project teachers were confident in their mathematical knowledge. All bar Caz trained as generalist teachers with mathematics specialisms. Caz gained a degree in early child

psychology, where she learnt how children learn, before a year's training in a local SCITT, which she valued highly. She believed that all teachers should understand learning theories and was disappointed that current teacher education models did not facilitate this. She believed not only that her course had achieved this objective but also that this was something she used in her own teaching. She was confident in her own mathematical knowledge, not least because she had been very successful at middle school, and had, at that time, become aware that she was considered *different* from her peers. Her subject knowledge, which emerged in all conversations, showed a deep and confident understanding not only of the structural connections within the mathematical topics she taught her class, but also between different subject areas. She regarded herself as an autonomous teacher, able to make decisions about how she presented mathematics to her class and was aware that her head teacher had recognised her skills in this area.

Ellie, Fiona and Gary all attended the same university and graduated with the same three year BA as specialist primary mathematics teachers. All three believed they were not only strong and confident mathematicians but also ambassadors of the subject. All had been, were currently, or in the process of applying to be either the mathematics coordinator at their school or a local authority leading mathematics teacher (LMT). Despite such common professional backgrounds, particularly as all described themselves as confident in their subject knowledge, there were substantial differences in their approaches to teaching the subject.

In sum, Fiona and Gary had similar background experiences as learners of mathematics and, interestingly, taught the subject similarly to their classes, held similar values and displayed similar pedagogical approaches. Ellie, on the other hand, had a different background and taught the subject differently. So it would appear that the data, despite similarity of qualification, highlight different beliefs about the nature of the subject and how it should be taught.

### **9.1.3            Being a teacher of mathematics**

An issue identified in all the initial interviews was the extent to which colleagues' discussions of mathematics reflected the latest official directives. Admittedly, they were all mathematics specialists, so perhaps this should be expected, but much of what they said was dominated by, for example, recent QCDA (2008) directives on assessing pupils progress (APP) and the vocabulary it brought with it. Indeed, all four were aware of the QCDA's APP guidance and

mindful of the need to use correct vocabulary when discussing children and their achievements. It could be argued that this acceptance and exploitation of vocabulary, vocabulary only teachers would be expected to understand, reinforces primary teachers' *professional identity*, not least because "our identities are composed and improvised as we go about living our lives embodying knowledge and engaging our contexts" (Connelly & Clandinin, 1999, p4). That is, continuing participation in this 'strategy led' vocabulary is not only a source of identity within the primary teacher community (Wenger, 1998) but the means by which they remain part of the primary teaching community.

#### 9.1.4 Conclusions

In conclusion, the initial interviews revealed both interesting and pertinent characteristics about the project teachers. When analysing their backgrounds, views and beliefs a dichotomy of experiences emerged: Caz and Ellie in one group and Fiona and Gary in the other. The teachers in each group shared similar background experiences and held similar beliefs about mathematics and its teaching (see table below 9.1). The results resonate strongly with earlier research highlighting the connections between beliefs formed during the early learning of mathematics and practice (Thompson, 1984; Ernest, 1989; Beswick, 2005). The characteristics of these two groups will be discussed below, but, crudely, the first group, Fiona and Gary, presents an instrumental perspective on mathematics and its teaching, while the second, Caz and Ellie, a relational (Skemp, 1976). Moreover, the evidence indicates that the members of both groups still enjoy the same things as when they were young, and that these formative beliefs are not only deep rooted but reflected in their perspectives on their own classrooms.

| Experientially-formed beliefs:<br>Beliefs as learner, trainee and experienced teacher.                        | Teacher |       |      |       |
|---|---------|-------|------|-------|
|   | Caz     | Fiona | Gary | Ellie |
| Believes they have a natural talent for the subject and strongly influenced by family views about the subject | ✓       |       |      | ✓     |
| Found mathematics unproblematic in their own schooling of the subject   |         | ✓     | ✓    |       |
| Found mathematics challenging but enjoyable in their own learning of the subject                              | ✓       |       |      | ✓     |
| Enjoyed a mechanical approach to mathematics at school – the challenge of working through text                |         | ✓     | ✓    |       |

|   |   |   |   |
|---|---|---|---|
| books and levelled cards of questions   |   |   |   |
| Influenced by courses and training in how children learn or the learning of mathematics   | ✓ |   | ✓ |
| Influenced by teachers they have worked with and Senior management team   |   | ✓ | ✓ |
| Concerns about children's engagement with the mathematical learning e.g. how children are grouped and how discussion develops learning<br><i>(social constructivist view, Jaworski, 1994)</i> | ✓ |   | ✓ |
| Concerns about children reaching targets and motivating children to work and achieve  |   | ✓ | ✓ |
| Believes the way mathematics is taught now is much better or more fun than when they were young   | ✓ | ✓ | ✓ |

Table 9.1: Comparison of Beliefs and Practice.

## 9.2. PART 2: Observed practice and rationale offered by teacher

The analyses generated two major perspectives on the whole class interactive phases of mathematics lessons, and provided important perspectives on my research questions. The first, as highlighted in the previous section, concerns what teachers believe they know and understand about mathematics and its teaching, where results reiterate that of previous findings (Beswick, 2007, 2012; Cobb, 1986, Desforges & Cockburn, 1987, Lerman; 1990, Thompson, 1984). The second, teachers' observed practice and the rationales they offer, has yielded three major categorisations. These categories I have called the teacher's Mathematical Intent (MI), Pedagogical Approaches (PA) and Classroom Norms (CN). These will be discussed in the following against the literature.

### 9.2.1 Mathematical Intent

The MI derives from the mathematical learning outcomes teachers were observed to privilege supported by their commentary, providing teachers' perspectives on my interpretation. Such a categorisation distinguishes mathematics from pedagogy. Five elements were consistently observed:

1. Prior knowledge activated
2. Connections
3. Vocabulary
4. Reasoning and approaches to memorising facts – knowledge acquisition
5. Tasks: examples used to demonstrate or model mathematics

All five, which are well documented in the research literature (Kilpatrick et al., 2002; Wood, 1988; Romberg, 1999; and Dochy et al, 1999), highlight well both similarities and differences in the four case study teachers' beliefs, practice and professional warrants.

### **9.2.1.1. Prior knowledge activated**

All teachers were seen to emphasise prior mathematical knowledge at the beginning of all observed lessons, although there were differences in their justifications for so doing. For Fiona and Gary the first step of every lesson was to bring to mind what their children had been learning previously. Occasionally, if children failed to respond as expected to direct questions they reminded them about activities they had undertaken together. For example, on one occasion Gary said '*remember when we had that polling booth in the classroom for the American elections?*' Both asked closed and tightly focused questions at the beginning of their lessons. As their stimulated recall interviews (SRI) showed, both saw this 'stepped-process' as part of their lesson structures. That is, both saw mathematical learning as being achieved through incremental instrumental steps (Skemp, 1976). Interestingly, neither, even when consistently prompted in interview, were able to articulate why activating prior knowledge was important. They spoke about what their senior management team, the Strategy (DfES, 1999) or OfSTED proposed as 'good practice', which may suggest they are majorly influenced by factors over which they believe they have little control.

In contrast Caz and Ellie gave their students time to think and talk to *talk partners* about what they remembered or what they already knew about a topic or question. This happened not just at the beginning but throughout lessons as issues or ideas arose. Both offered clear mathematical reasons, for example, giving time for children to think mathematically. In interview Caz offered clear reasons, based on her psychology-inspired understanding of how both children's understanding and mathematical concepts are built upon previous material. Such perspectives accord well with the literature on the construction of mathematical knowledge (Alexander et al., 1996; Anderson, 1982; Dochy et al., 1999, NCTM, 2000).

### **9.2.1.2 Connections**

Effective teachers of mathematics attend to connections between mathematical concepts, which is reflective of a focus on deep conceptual knowledge (Askew et al., 1997; Brown et al., 2001; Leikin, and Levav-Waynberg, 2007; Leung, 2005). Interestingly, and indicative of the importance of language in the construction of such connections (Barwell, 2005, Leung, 2005), project teachers were observed to make both explicit and implicit connections.

Caz seemed to fit Askew et al.'s (1997) connectionist descriptor well. She regularly made explicit connections between different elements or concepts of mathematics. For example, she was observed to hold a counting stick horizontally to model a number line before turning it through 90° and describing it as a scale. She commented regularly on the importance of making connections during whole class interactions, believing that such representations *help children read scales...like... on a thermometer... particularly when the scale on the 'Y' axis does not represent one*' unit. She was aware, also, of avoiding colluding in the construction of children's misconceptions. She commented that a *common mistake children make is assuming each line up the y-axis is one, so I do not always count in ones on the counting stick*. In such actions Caz responding to both her perception of her children's needs and her ambition to *take them a little further on and make that connection for themselves*.

Interestingly, Ellie was rarely seen to make explicit connections, although she frequently provided opportunities for children to make them for themselves. For example, during a discussion on tessellations a boy described a quadrilateral, formed by cutting a section from a triangle, incorrectly as a '*truncated triangle*'. In interview, Ellie explained that this particular boy had been exploring solids the week before and, having spotted a truncated cone, wanted to know what it was called. Ellie explained that she tried to encourage children to develop both enthusiasm and a sense of enquiry, and that this kind of connection was not unusual and, she argued, extremely encouraging. In this example lies an alternative perspective on Askew et al.'s (1997) perspectives on connections. Ellie appeared to encourage a public exploration of ideas and discussion where children frequently asked questions to make connections for themselves. She did not prompt in the manner of Caz but offered opportunities for children to go beyond her planned learning intention.

Fiona made no explicit connections between areas of mathematics, but did make use of concrete materials to illustrate concepts; for example Unifix® cubes were used to illustrate the partitioning of two digit numbers. However, observations showed children confused by such representations as her vocabulary of *big ones* (tens) and *little ones* conflicted with the place value cards she had used to introduce the topic. In interview she indicated that she had not thought this was an issue as she had 'told' the children how the concrete material (Unifix®) was connected to the concept of place value. This particular event was not atypical and seemed indicative of a lack of professional awareness of the impact of her actions on her children. Such a problem highlights the critical role of reflection on practice (Conway,

2001; Griffiths and Tann, 1992; Korthagen and Wubbels, 1995; Schön, 1983) and the need for appropriate CPD, as highlighted by the Williams Review (2008). Interestingly, when invited to talk about mathematics teaching, Fiona consistently emphasised the *telling* of concepts to children.

It could be argued that elements of Fiona's beliefs and practice drew on her being responsible for young children, whereby she saw her role as guide and nurturer rather than as facilitator of independence (Gonco and Rogoff, 1998). Such perspectives are understandable when seen against recommendations for early years practitioners to find ways of 'helping', 'supporting', 'enabling', 'giving time' or 'promoting' particular understandings' (Siraj-Blatchford et al., 2002, p.40). Such vague invocations, particularly when presented to teachers in receipt of little pedagogy-related CPD, may encourage idiosyncratic emphases, which, once actioned, become part of an everyday pedagogical repertoire.

Gary made explicit connections between activities, rather than mathematical concepts, throughout his observed lessons. For example, he talked about the ways in which the class collected data during a mock poll related to the US Presidential vote but not about the data themselves. That is, in the mind of the teacher the connection was made to the mathematics, but in the minds of his children the connection was made to the activity or context and not the mathematics (Fennema et al. 1993).

In summary, Gary and Fiona emphasised *what* (through the public presentation of detailed learning objectives) was to be learnt, believing this was where connections were made. In their post-lesson interviews both indicated repeatedly that this was the most important part of any mathematics lesson. It signposted *what* the children were going to learn and they were frequently able to check that the day's objectives had been assimilated. So prevalent was this particular practice that their students had learnt that the answer to any question posed to them could be found in the lesson objectives or the success criteria written on the board. For Fiona and Gary, this was making connections in mathematics. Caz and Ellie, on the other hand, offered only broad objectives on their boards; for example, *today we are learning about time*. In whole class activity they focused extensively on connections within mathematics. They did not see the learning objective as being of any great cognitive value; but as a broad focus which they expected their children to unpick for themselves. This was scaffolded through the tasks offered and open public discussion based around them.

### 9.2.1.3 Vocabulary

A different issue highlighted the extent to which teachers provide opportunities for children to engage appropriately with key mathematical vocabulary. Ellie and Caz, for example, frequently used games to encourage exploration of new and unfamiliar mathematical vocabulary. Gary and Fiona, conversely, provided lists of words, expecting children to use these in response to closed questions, and would frequently read out these words during their lessons. Such practices, it seems, facilitate either mathematical thinking (Schoenfeld, 1992) or behavioural responses as highlighted in von Glaserfeld's (1991) distinction between *teaching* children and *training* children. He adds that teachers have a better chance to modify students' conceptual structures if interventions are informed by a model, as in opportunities to use key vocabulary, such as a game.

An example of Ellie's emphasis of vocabulary was seen through the development, over several lessons, of a mathematical dictionary. Created through class discussion, some words arose unexpectedly, while others, for example, vertex, were planned. She announced that children should try to use the listed words when playing games during the OMS. Interestingly, Ellie had been praised by visiting teachers, as part of the LMT local authority programme, over the quality of her students' vocabulary. However, she had not perceived herself as doing anything different from anyone else, stating that she did what she thought was necessary for her children to learn and use mathematical vocabulary appropriately.

In contrast, in addition to encouraging her children to copy key vocabulary onto their white boards, Fiona would encourage them to repeat the words aloud. She commented during interview, *I want them to begin to recognise the words ... because in the framework one of the things is to begin to write ...down, make them recognise it.* She always read out the framework-related vocabulary, before checking her children's understanding. A year one teacher, Fiona corrected children's misunderstandings and mispronunciations, for example she would repeat words e.g. **seventeen**, **not seventy** emphasising the endings. However, she said, in a post lesson interview, that she paraphrased the framework's vocabulary in her children's language, in accordance with PNS strategy guidelines (DfEE, 1999, DfES 2008). This, it seems to me, was one of the root causes of confusion in Fiona's lessons. For example, following her use of a row of ten Unifix® cubes during a lesson on place value she commented that *if children don't understand the word 'block' then they might understand the word 'tower' or they might understand 'lots of'. So I tend to throw different vocabulary at*

*them, because some children might not understand just one of those words.* This element of Fiona's practice highlights a debate in the literature. On the one hand research informs us that children need to use the correct vocabulary to understand the concepts (Barton & Neville-Barton, 2003; Leung, 2005; Barwell, 2005). On the other, specific language issues can either hinder or scaffold new learning in young children Bruner and Olsen (1978) and Gallas (1994). However, Tsamir et.al. (2011) argue strongly that young children mimic adults and so it is important that adults use correct and precise mathematical language.

In Gary's school the SMT insists that all key vocabulary and learning intentions are listed on the board every day for each part of a lesson. Each word and objective is then ticked off when *covered*. What appears to have evolved, as a consequence, is that children do not *have* to think when asked a question as the answer is on the board. For example, when his class was asked how they could present a set of data children looked at the board and one said 'tally chart', as that was the first relevant word in the list. This was incorrect and so a second child suggested the *correct* pictogram, as that was the second word on the list. Such circumstances, reflecting an unequivocal 'instrumental learning' (Skemp, 1972), may account for Gary's perception not only that his children frequently fail to understand but also why he frequently finds himself repeating lessons or continually *practising skills*.

Both Gary and Fiona saw the use of language as unproblematic; they both wrote lists on their boards in order to *support* their learners. However, observations indicated that their children had been *trained* to scan the board for the answers to almost all questions asked of them. They both construed this as a form of nurturing with regard to how they expected their children to learn mathematical vocabulary. Both talked about how they *know their class* and therefore what works for them, in the manner of the child-centred Reggio Emilia approach described by Malaguzzi (1993). It could be argued then, that such views match their core beliefs about learning mathematics; children are shown the vocabulary, therefore they will learn it. These are unproblematic issues for them.

#### **9.2.1.4      Reasoning**

Expectations that children would think mathematically and engage in reasoning were consistently observed throughout Ellie's and Caz's lessons. Caz encouraged children to 'argue' with her if they were confused by or disagreed with anything she had said. During one fractions-related episode she had failed to notice an ambiguity in her presentation of a

problem. It went, if there are two cake and six people, represented as they are the diagram (figure 9.1), how many pieces will each person get?

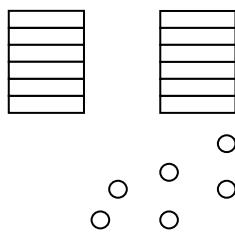


Figure 9.1: Cake slice

One child, Jamie, said, correctly, that they will have one sixth of one bar and one sixth of the other before concluding, that each person would have two sixths altogether. Another child, Holly, pointed out that it should be two twelfths not two sixths. This created a lengthy discussion amongst the class and although some children had clearly accepted Holly's explanation, Caz explained later that she was eager to discuss the cognitive conflict as she wanted to make sure that Jamie's conclusion had not confused anyone. Children's misconceptions develop easily and teachers' unacknowledged failures may be contributory to their development (Askew & Wiliam, 1995). Fortunately, Caz has a secure subject knowledge, a recognised marker of the competence of a good mathematics teacher (Ma, 1999, Ball & Bass, 2000; Rowland & Ruthven, 2011), and was able to recognise not only the problem as it arose but work on reconciling the two perspectives.

Fiona did not emphasise reasoning or thinking in any discussion we had. Her focus was on pedagogical approaches to mathematics rather than the mathematical learning. This was an interesting observation as her explanations to children were focussed on the '*how to do...*' something rather than what it is connected to, or *why* they were learning this element of mathematics, other than it was an assessment *target*. In similar vein, Gary's core mathematical intent was the acquisition of knowledge necessary for passing the SAT tests, manifested in his frequent use of mathematical memorising exercises. Indeed, Gary was adamant with respect to the importance of such practices in mathematical learning, often emphasising the role of tricks, practising and the memorising of facts, just as when he was a child at school. Such findings resonate closely with the findings of beliefs-related research (Thompson, 1984; Beswick 2005, 2007, 2012), whereby teaching is 'rooted in deeply held beliefs about the nature of the subject, the way students learn, and the role of the teacher' (Stigler & Hiebert, 1997, p19).

To summarise, with respect to the development of reasoning, Gary's and Fiona's practice presented few, if any, opportunities. I am not convinced they did not think about it but that they simply saw it as unproblematic. For them, mathematics was about how they taught; it was not about the cognitive engagement of their children. Their focus resonated with Skott's (2009) teachers who subordinated cognition to their children's emotional responses, attending to whether they were having fun while learning.

#### **9.2.1.5 Tasks: examples used to demonstrate or model with**

Mathematical tasks have been included into the MI category as this was a significant difference between Caz and Ellie's practice on the one hand and Gary and Fiona's on the other. The nature and role of mathematical tasks is an increasingly well-researched field (Hiebert & Wearne, 1993; Smith & Stein, 1998; Stein & Lane, 1996; Zaslavsky, 2007; Watson & Mason, 2006), as the choice of task can be as significant to a child's mathematical progress as a teacher's input. Caz and Ellie demonstrated an understanding of where the concepts they were teaching would lead and chose specific tasks as a consequence. These were not always prior planned as frequently they were introduced as a consequence of a critical moments in whole class teaching episodes. This mathematical emphasis was recorded in both the lesson observations and the interviews that followed. Both teachers explicitly mentioned the *bigger mathematical picture*, in other words, where the new learning fits with other elements of mathematics. For example, on one occasion Caz linked the history of sun dials to an explanation of why clocks are round and the measurement of turn around a point.

Real-life situations were something only Caz and Gary mentioned in their post lesson interviews, although the ways in which this was presented differed. Caz tended to draw on her children's real life experiences to illustrate or reinforce a concept. For example, during a lesson on time, she emphasised the irregularities in people's abilities to reference the passing of time by asking them to identify aspects of their lives related to the notion of one minute. *For Latia it was about mathematics in dancing, for Josh it was about swimming and for Tom it was about scoring a goal.* Caz used such serendipitous moments in WCI discussion to engage children to think mathematically through links to their real-life experiences.

In contrast, Gary also referred to real-life situations but directed his children to specific events like the American presidential elections they had modelled. His justifications were similar to those of Caz, drawing on the importance of real-life situations, but the difference

was that Gary provided both content and context, whereas Caz provided the content and invited her children to come up with their own context through thinking about the relationship and connection between the mathematics and the real-life situation. The manner and the rationale both teachers offered suggested that Caz saw this as the responsibility of her children, whereas Gary saw it as his responsibility, thus doing their work for them.

Neither Fiona nor Ellie emphasised real-life situations in any of their observed lessons. However, this does not mean they do not practice this.

### 9.2.1.6 Summary

A summary of the four teachers' **Mathematical Intent** is shown in table 9.2. In it can be seen quite clearly their similarities and differences, which indicate that the four teachers fall into two groups. One group, Caz and Ellie, provides opportunities for children to think and explore collectively while making connections. This group also provides opportunities for children to use their vocabulary in appropriate tasks and emphasises enquiry, argumentation and justification through those tasks. Finally, and unexpectedly, the observations and later discussion, indicate, perhaps unwittingly, who works the hardest in the WCI phases, the children or the teacher.

| MI  | Emphasised  | Caz | Fiona | Gary | Ellie |
|---|---|-----|-------|------|-------|
| <b>Prior knowledge</b>  | Activation is emphasised at the beginning of every lesson to remind children of previous work   | ✓   | ✓     | ✓    | ✓     |
|   | Activation of prior knowledge is a consistent part of whole class interaction.  | ✓   |       |      | ✓     |
| <b>Connections</b><br><br>Implicit versus explicit connections.<br><br>Assumptions are made by teachers about what their children are thinking in whole class interaction. The complexities are problematic as it draws on their view or belief about how children learn. | Implicit connections are made by the teacher  | ✓   | ✓     | ✓    | ✓     |
|   | Explicit connections are made by the teacher  | ✓   |       | ✓    |       |
|   | Teachers provide opportunities for children to make implicit connections for themselves through time to think discuss and try out ideas       | ✓   |       |      | ✓     |
|   | Teachers do not provide many opportunities for children to make connections for themselves because of time constraints. It is quicker for the |     | ✓     | ✓    |       |

|  |  |   |   |   |
|--|--|---|---|---|
|  | teacher to tell them.  |   |   |   |
| <b>Vocabulary</b> emphasis:<br>Training to behave versus teaching to use.<br><br>All teachers emphasised new or key vocabulary at the beginning of their lessons, but were training the children to use them at directed points, not as part of a task where they need to use them e.g. through a game.  | Teacher emphasises vocabulary in training children to use mathematical vocabulary                                      |   | ✓ | ✓ |
|  | Teacher emphasises vocabulary through providing opportunities to children to use the vocabulary e.g. games.            | ✓ |   | ✓ |
| <b>Mathematical reasoning</b><br><br>There is a very strong relationship in the project teachers to their core beliefs about learning. E.g. argumentation; unproblematic so needs to be very little discussion; memorise facts to be successful.   | Emphasised a development of enquiring, justifying, organising, reasoning, exploration, explanation and decision making | ✓ |   | ✓ |
|  | Emphasised organising, recording, checking explaining solutions  |   | ✓ | ✓ |
| <b>Mathematical Tasks</b><br><b>Who does the work?</b><br><br>Good tasks are mathematical and provided by teachers who understand the complexities of mathematics (Watson & Mason (2004) teacher knowledge – PCK). They are dependent on the level of engagement by the learner, and not by the teacher for example teachers provide the context and the children provide the content. | The teacher works the hardest  | ✓ | ✓ |   |
|  | The children work the hardest  | ✓ |   | ✓ |

Table 9.2: Comparison of four teachers' emphasis in MI

### 9.2.2 Pedagogical Approaches

In the following I discuss each teacher in relation to the pedagogical approaches (PA) they adopt. Nine PAs were yielded by the analyses and these form the basis of the discussion. These were:

1. Lesson structure
2. Questioning
3. Discussion
4. Explaining
5. Visual aids, resources and images used
6. Fun
7. Psychology

8. Expectation and differentiation
9. Assessment

### 9.2.2.1 Lesson structure

The following provides an overview on how the teachers structure their mathematics lessons. It helps explain why individual teachers act the way they do during WCI phases. WCI was observed in OMS, the introduction to the main part of a lesson and in lesson reviews; which may happen at various points in a lesson as well as at the end.

The OMS was an important lesson component for all four teachers. Three teachers began their lessons with an OMS related to the concept to be delivered in the main part of the lesson. Fiona did not. In interview she said she quite liked the OMS to focus on a different area of mathematics as she believed it to be *boring* for the children if it was not. She said *I think it gets them stimulated more. If they were doing the same thing the whole lesson long, it can get a bit boring and drag on a bit for them. I think it's more challenging for them as well*. Interestingly this contrasted with what was said in her initial interview, where she explained that she made links between the starter and the main activity, although this was never observed. For example, in one lesson the OMS focused on addition when the body of the lesson was on subtraction. No explicit link was made between the two concepts (or episodes) other than her assertion that *we must practise to make us good*. This approach will be explored further later.

Official guidance, with respect to the relationship between the OMS and the main body of the lesson, is loose. The NNS (DfEE, 1999) indicates that the ‘first 5 to 10 minutes of a lesson can be used in a variety of ways to rehearse and sharpen skills, sometimes focusing on the skills that will be needed in the main part of the lesson’ (NNS section 3/99). Similarly, Ofsted suggests that an effective primary teacher ensures ‘that momentum is maintained during transition from the mental/oral starter to the main part of the lesson, especially where the starter activities are unrelated to the main focus of the lesson’ (DfES, 2005, p4). The evidence of this study is that teachers tend to have a clear view on the matter, some preferring to link the two parts and others not.

Both Gary and Fiona’s lessons were methodically organised and executed. Each had three parts and each comprised a number of learning objectives and success criteria (steps to success – Fiona; top tips – Gary). This seemed to contrast with OfSTED’s (2005, 2006) recommendation, which is to have few and focussed objectives. Fiona always read the whole

list out to her class, for they were never presented in children's language, which the PNS (2003b) guidance suggests. An example from one her lessons can be seen in figure 9.2.

Lesson 3 Learning Objectives:

1. To be able to count back from any number up to 20
2. To partition numbers into tens and units
3. Begin to order 2-digit numbers

Figure 9.2: Fiona's LO lesson 3

Having said that, Fiona took great care and time in explaining what each objective meant and continued until she was satisfied that they understood *what* they would be learning. She saw her explanation as an important part of her role as a teacher. As reported earlier in chapter six (case), she used a hand puppet called Learning Lion to do this. She did not know where the puppet idea came from only that she thought the whole school used the same puppet. She believed ...*they respond to it very well, actually, surprisingly. I thought they might get a bit bored with it after so many lessons but... they tend to like it so.... it works well.*

Success criteria

7. Count carefully
8. Count backwards
9. Use your sticky finger to point to the numbers
10. And when you count backwards you are taking away.
11. You have got to find the right number to start from
12. Concentrate

Figure 9.3: Fiona's Success Criteria L3

Her success criteria often comprised several points, as shown in figure 9.3, and were presented through the use of another puppet. She said

*Successful Snake is the success criteria ...what you want them to achieve by the end. Or sometimes I use it to get them to tell me what Successful Snake should have said. 'cos sometimes he's naughty and he forgets to say things... which is absolutely hilarious... they tell him off and then they tell me what to type in (on laptop) what Successful Snake should have said.*

She explained that the snake was used randomly with the success criteria but the children really enjoyed seeing him. This was something that she and her class clearly enjoyed as part of their daily routine and will be discussed as such in the classroom norms section later in this chapter.

Gary too had a precise and well-structured routine for presenting his learning objectives, success criteria and vocabulary for the main body of the lesson and, in addition, had objectives and ‘top tips’ for the OMS. The learning objectives and top tips were colour coded on the board. He explained there were many as they were *short and snappy*, and he expected children to refer back to them throughout the lesson. Sometimes he would explicitly refer to it, perhaps point to it, when prompting answers in whole class questioning. Throughout his lessons Gary continuously referred to the *top tips*, which he explained was an emphasis for him in Literacy lessons also. The phrase ‘top tips’, introduced by his school’s mathematics’ coordinator and SMT, was thought to be an effective way of breaking down the language for children. It had become a whole school initiative, being based on a belief that it made learning easier for children. Gary emphasised a quick pace in all his lessons. He was aware (through management observations) that he often talked quickly and moved lessons on quickly, and this was regularly observed; he altered pace and direction constantly, particularly in what he referred to as ‘practice lessons’. These lessons usually followed a test and were not focussed on one concept, as there were weekly tests and weekly *mop-ups*.

In contrast Caz and Ellie presented broad learning objectives and were never seen to write up a list of success criteria. The structures of their lessons were similar and, in addition to the main body of a lesson, incorporated an introduction and some form of rounding-up of ideas and difficulties at the end.

Caz’s school was experimenting with cross curricular themed sessions, which were not necessarily simple blocks of forty to sixty minute. Some days there would be two lessons, others five, depending on the theme being explored. Caz’s observed lessons sometimes ran into the afternoon; the point here being that she was flexible and relaxed about her lessons. She talked about how the school had gone through a transition in its approach and the staff had noticed real differences in children’s engagement with their learning. She said confidence and achievement had improved as a consequence of these changes and the feeling of a *stressful rolling treadmill* of daily subject after subject, with the dissatisfaction of not finishing anything properly, had disappeared for staff as well as children. This was an interesting observation, and one which Alexander (2009) suggests has been the subject of little research.

Ellie would always display an overview learning focus on the board, for example, *we are learning about time*. Yet every day they would be working on a different aspect or picking things up from where they left off the day before. Ellie said that

*when it's the first lesson I would normally write it up and we'd pull it all apart. Looking at all the words and what they mean... because the learning objective will stay the same for a period of a few lessons, maybe even a week, and because the context is taken out of it so... if it was... 'we are learning to measure time' it doesn't matter what they are doing, they are still learning to measure time so then the next successive lesson I would expect that the children would be able to tell me.*

In sum, a further dichotomy appears between Fiona and Gary on the one hand, and Caz and Ellie on the other. Gary and Fiona present learning objectives straight from the PNS directive for their year group in detail. Caz and Ellie use broad titles for a unit of work on a particular area, like 'we are learning about shape'. A significant point of difference is that Fiona and Gary saw it as their role to explain and tell their class daily what each element meant. Caz and Ellie, with guidance, hand over the examination and explanations to the children. This is an interesting difference and resonates well with a recent OfSTED report (2009) on effective mathematics teaching in primary school. Relevant aspects of the report are shown in table 9.3.

| Features of good mathematics teaching   | Features of satisfactory mathematics teaching   |
|---|---|
| Lesson objectives involve understanding and make what is to be learned in the lesson very clear.  | Lesson objectives are procedural, such as descriptions of work to be completed, or are general, such as broad topic areas.  |
| Teaching successfully focuses on each pupil's learning.<br>Pupils are clear about what they are expected to learn in the lesson and how to show evidence of this.<br>Teaching successfully focuses on teaching the content of the lesson. | Pupils complete correct work and are aware of the lesson objectives but may not understand what they mean or what they need to do to meet them.                     |
| The lesson forms a clear part of a developmental sequence and pupils recognise links with earlier work, different parts of mathematics or contexts for its use.   | The lesson stands alone adequately but links are superficial; for example, links are made with the previous lesson but not in a way that all the pupils understand. |

Table 9.3: OfSTED, (2009, p4) Features of good mathematics Teaching

Looking at table 9.3 the two elements highlighted (blue) indicate that satisfactory teaching provides 'broad topic areas' to children in their procedural learning objectives. If one compares this to the cases then both Caz and Ellie would be deemed as simply satisfactory

teachers, yet the third point (**red**) indicates that ‘The lesson forms a clear part of a developmental sequence and pupils recognise links with earlier work, different parts of mathematics or contexts for its use’ (2009, p4), which is what Caz and Ellie did with their *broad* learning objectives. This highlights how such documents can be interpreted differently. Ellie’s and Caz’s schools advocate broader headings than Gary’s and Fiona’s, which expect children to engage with details prior to learning. This evidence highlights the complexities of teaching strategies and guidance materials. The PNS stressed that ‘it is easy to misinterpret this model by treating it as a simple linear process or omitting essential elements altogether’ (DfEE, 2000b, p11), and in mathematics education specifically, ACME (2006) emphasises how primary teachers misinterpret pedagogical advice.

Finally the evidence suggests that primary teachers experience a variety of constraints in their school settings. There is increasing evidence, such as the William’s Review (2008) and the Cambridge Primary Review (Alexander, 2009), that teachers feel under pressure. Such pressures do not come solely from PNS directives, they also come from a school’s SMT. For example, Gary felt constrained by the number of LOs that had to be covered within a two-week unit of work. This, together with the pressures of his school’s Christmas production rehearsals, was part of the pressures he discussed at interview. The new APP documentation (QCDA, 2009) had been misinterpreted by Gary’s SMT in ways that necessitated his collecting evidence and undertaking summative assessment as a planning tool for each child. This was causing him and other members of staff great anxieties about workload. The point I make here is that he already felt pressure, due to performance management expectations, to move children through two achievement sub-levels every year. He said *If you don’t move them, you ain’t a good teacher! If you don’t move them they’ll consider your pay rise!* Such pressure could lead to teachers implementing approaches without questioning, without a consideration of the effects on not just learning but the children and the teacher. This is an important issue as such pressures will indirectly influence a child’s learning opportunities, as the OfSTED (2009) report implies, and will be discussed further in the next chapter.

### 9.2.2.2 Questioning

The role of questioning in the construction of learning is well documented in the mathematics education literature (Alexander, 2000; Amos, 2002; English et al., 2002; Galton & Hargreaves, 1999; Mercer, 1995; Moyles, 2003; Rop, 2002; van Zee & Minstrell, 1997;

Watson & Mason, 2007, Williams, 1984; Wood, 1998). According to both the NNS (DfEE, 1999) and the PNS (DfES, 2003b), *questioning* is used to reactivate prior knowledge and develop mathematical thinking. In this respect, all four teachers espoused and enacted questioning approaches to remind, prompt and encourage children to think about their prior knowledge at the beginning of their lessons. However, while much of their questioning fell into the IRF (or IRE) categories (English et al., 2002; Flanders, 1970; Lemke, 1990; Mehan, 1979a; Sinclair & Coulard, 1975), where little student engagement was expected or necessary, there were exceptions that dichotomised the teachers. Fiona exploited the IRF sequence, explaining that she asked questions for particular reasons such as a reminder, to challenge, or to motivate them to think and to differentiate. Although Fiona espoused the use of talking partners, this was never observed in her practice.

Gary questioned differently, frequently exploiting, in very deliberate ways, strings of closed questions delivered at a sharp pace. He explained that he picked someone to answer, often *target children*, but would change tack if he wanted to move the lesson on quicker by asking children he knew would know the answer. Questions typically related to the learning objective, top tips or vocabulary, but occasionally he appeared to ask open questions like '*tell me what you know about place value?*', which is not quite as open as those encouraged in the mathematics education literature (Watson & Mason, 2007) as he commented at interview that typically he ...*was looking for particular answers*. Thus, his range of questioning was superficially diverse yet controlled; he directed classroom discourse in ways that allowed him to dictate a narrow path of thinking. I propose that he exploited *inauthentic* open questions, as they seemed more focused on quick recall than the stimulation of deep thought and were clearly not what is meant by the definitions of *open questioning* found in the literature (Mortimer & Scott. 2000, 2003; Tsui et al. 2004). The time Gary provided for children to think about a question was also limited (four or five seconds at a time) and fitted well with the tradition he had developed whereby children had learnt that answers were on the board, marginalising both thinking and engagement. Very little sharing of ideas was witnessed in his lessons, as found in many classrooms since the introduction of the strategy in primary schools (Moyles et al., 2003).

Caz and Ellie, by way of contrast, were seen to exploit both discussion and open questions to help children make connections. Both actively encouraged children to formulate their own questions, to be posed to both teachers and each other, as recommended by Alexander

(2008b) and Dawes (2010), in what appeared to be ‘normal’ behaviour in the WCI phases of their lessons. They took time to develop and, essentially, *train* their children to discuss in pairs. Thus their children demonstrated mathematical thinking through the questions they asked publically and the responses yielded by the rest of the class. Such practices resonate closely with Vygotsky’s (1986) social construction and Bruner’s scaffolding of knowledge. Moreover, they accord with Watson & Mason’s (2007) perspectives on the need for learners, through the co-construction of new knowledge, to be allowed to act like mathematicians.

Conversely, Fiona and Gary asked closed questions focused on the collective production of a single, correct, answer. Such approaches constrain mathematical thinking by closing down the openness of the questions and narrowing opportunities for the learners to think make connections or experience behaving like a mathematician (Watson & Mason, 2007). Their intentions were to ‘scaffold learning’ through questioning but, as Schoenfeld (1989) reported in his study, such an approach encourages a narrow engagement and limited understanding.

### 9.2.2.3 Discussion

An analysis of discussion revealed different insights into the four teachers’ practice. Fiona and Gary espoused a practice rich in classroom discussion, but their enacted practice indicated little, as previous studies have shown (Alexander, 2000; 2004.; Ball, 1993; Cazden, 2001; Galton, 1999; Lambert 1990; Mercer, 1995; Moyles, 2003; English et al. 2002 and Pratt, 2006). Caz and Ellie were found to be very different.

Discussion, as defined by Anghileri (2006), Ball (1993), Cobb et al. (1993), Lampert (1990) and Mehan, (1979), was never seen in Fiona’s classroom. She was observed to work solely within an IRF format, with feedback typically taking the form of *good girl* or *that’s a good answer*. There appeared to be no integration of whole class discussion observed in her practice. However, she was working with year two and year one classes during filming, so one could argue that very young children were less talkative or argumentative than older children. She also commented regularly that her children were below the national average on a range of measures, implying that she had low expectations of the children and their capability for discussion.

Gary espoused ‘maths talk’ and class discussions but his observations belied this, with discussion being reduced to the string of closed questions highlighted above in which only

one child was ever asked to respond. Moreover, the majority of talk was Gary's rather than his children's. There was little discussion observed between talking pairs of children, although he believed he exploited paired-talk regularly. His observed practice revealed, as in figure 9.4, a consistent pattern of:

- Teacher questions whole class
- Teacher asks individuals to answer the question.
- If after asking three children the correct answer was not provided he offered the question to the whole class to discuss with their partners.

Figure 9.4: Gary's pattern of WCI questioning

When asked about the inconsistency between espoused and enacted practice Gary reflected that he used discussion more in other subjects and in other parts of the day.

In contrast Caz and Ellie explicitly encouraged children to talk about the ideas and activities they worked through as a class. They encouraged children to voice their ideas publically, sharing interests and difficulties with the rest of the class. Caz believed in encouraging children to discuss mathematics publically and to deal with the difficulties mathematics throws up. She commented, in ways resonant with Dweck's (2006) argument that learning requires effort, that, *if they're hard you are more likely to be learning something.... that feeling that really stops some children from learning in maths, where they say, 'I can't do it, I don't know the answer'*. Caz wanted children to realise ... *this is only (difficult) at the moment, in a few weeks it won't be so hard*, and encouraging children to share their difficulties was part of her approach to discussion. The school in which she worked had systematically encouraged high quality discussion; talk partners, which were allocated randomly, were changed every three weeks. Her view was that *I don't think there are any other disadvantages really*. Caz was also seen to remind children, before they began a long discussion, what the 'rules' were for talking partners; *listen to your partner's ideas and then explain your idea and why you think that*. Ellie was observed to develop children's mathematical thinking in similar ways. Children were encouraged to listen to other's points of view and ideas. Extended discussion appeared to be a typical occurrence, where children asked questions, for example talking about what they had seen in a picture, and explored misconceptions.

To summarise, the two groups of teachers, despite similar espousals, enacted very different conceptions of discussion, highlighting well how discussion may be directly related to a teacher's personal view and interpretation of what discussion is and what it should be in a classroom (Boylan, 2004; Pratt, 2006 and Alexander 2008b).

#### 9.2.2.4 Explaining

Explanations, in the general sense, are regarded in the literature as 'ubiquitous tools...to communicate, key concepts, principles, and relationships' (Roscoe & Chi, 2008, p321), which King (1994) asserts should be relevant, coherent, complete, and accurate. The data suggest that explanation takes many forms during whole class phases of lessons. Two of these are examined here.

- explaining through *modelling* and *demonstration*
- explaining through *prompting* and *telling*

But first, although the four teachers rarely used the word explain during either their interviews or their lessons, suggesting that it may have disappeared from primary teachers' professional vocabulary, all four mentioned the qualifiers above.

Fiona and Gary were observed to *explain* various aspects of the tasks they presented. For example, they explained vocabulary and what they were going to be doing in the lesson. When questioned, Fiona could not articulate what it was she was doing. However, during one interview, she was able to explain why she repeated an activity, seen at the beginning of a lesson, and at the end. She said that *because they hadn't done this before it needed reiterating again*. In so saying, it is interesting to note that *explain* seemed not to be part of her vocabulary.

In similar vein Gary did not emphasise *explaining* in his interviews. He talked about how he instructed children to explain, particularly during whole class discussion. However, the observations, as described above, indicated that classroom discussion followed an IRF format, whereby little *explaining* by children was seen; they merely offered answers to specific questions. Indeed, when children got things wrong in their fortnightly, half term or full term tests, Gary went over and over the elements the majority had got wrong, dedicating large parts, or even whole lessons, to explaining *how* to do the calculations, *how* to set them out before practising them repeatedly in a practice redolent of Fiona's *really going back to basics, really drumming it in to them*.

The disappearance of explain from colleagues' vocabulary may find its roots in the NNS (DfEE, 1999). In stressing the use of direct teaching, and mentions *explaining and illustrating* as one of its foci, it provides a detailed list of other skills a teacher should be exploiting as part of an effective mathematics teaching repertoire, which are shown in table 9.4.

|                             |
|-----------------------------|
| Directing                   |
| Instructing                 |
| Demonstrating               |
| Explaining and illustrating |
| Questioning and discussing  |
| Consolidating               |
| Evaluating pupil's progress |
| Summarising                 |

Table 9.4: NNS. (DfEE, 1999) Teacher Guidance(see appendix 9.1 for full version)

Moreover, the PNS guidance of 2005 (repeated in the 2011 online guidance) expands this list (table 9.5) to the extent the word *explain* has now all but disappeared, whereas other elements have been developed to provide *Ten approaches to the teaching of mathematics* (for full list see appendix 9.2).

|    |  |
|----|--|
| 1  | Plan and provide <b>exploration, acquisition, consolidation and application</b>  |
| 2  | Share the <b>excitement of learning</b>  |
| 3  | <b>Model, direct and steer children's learning</b>   |
| 4  | Give children opportunity to <b>consolidate</b> their learning   |
| 5  | <b>Engage</b> with children's thinking   |
| 6  | <b>Demonstrate</b> and promote the correct use of <b>mathematical vocabulary</b>   |
| 7  | Provide children with the <b>well-directed opportunity to use and apply ...explain</b> their results and methods, using their own approaches and strategies. |
| 8  | Teach children how to <b>evaluate solutions and analyse methods</b>  |
| 9  | <b>Review children's learning</b>  |
| 10 | <b>Model</b> with children how they identify, <b>manage and review</b> their own learning.(  |

Table 9.5: PNS. DfES,2011. see appendix 9.2 for full version)

The word is mentioned only in the seventh approach which directs teachers to encourage children to ‘draw on their ideas and model approaches and strategies children can use to support a line of **enquiry** or to interpret or **explain** their results and methods, using their own approaches and strategies’ (DCSF, 2011. p4). However, this emphasises the importance of children explaining and not the teacher. In short, explain seems to have been given a sanctioned removal from teachers’ professional register.

#### 9.2.2.4.1 Explaining through modelling and demonstration

The meanings of modelling and demonstration, as found in the literature, were examined in chapter two (DfES 2004; Hatano et al. 1992; Hattie et al. 1996; Muijs & Reynolds, 2001; Johnson-Laird, 1985). Here I consider how project teachers construed them and highlight substantial differences in interpretation.

Caz and Ellie demonstrated and modelled approaches to tasks in every lesson observed. Sometimes this would be through modelling how to use key vocabulary, other times it was to demonstrate how to play a game. Caz explained that demonstration was a very specific pedagogical strategy, saying that *demonstration is different from Modelling. It is directing the children's thinking; giving them questions they could answer and break down the concept of new learning into parts*. She added that *demonstration is demonstrating mathematical concepts*. The activity of demonstration appears for Caz to be part of a whole. That is, she will ask children questions as part of a step-by-step progression of mathematical explanation.

Modelling she explained

*is very different... If I'm modelling, then I would work as a year 4 would work. And I would try to articulate the thinking a year 4 would have... If I was drawing an array, (I would say) "right first number is 4 so I need four columns and my second number is 5 so there needs to be four dots in each column". But then also make mistakes ... common errors I'd expect them to make... to show them that it's ok to make mistakes. Demonstration is demonstrating mathematical concepts, where modelling is more about me showing them what year four should be doing.*

She saw modelling as ‘modelling behaviour’, adding *how I want them to go, what I then want them to do. So there is always an expectation*. This idea was supported in later interviews. The most interesting point here is that Caz appears to be very clear in her own mind about what demonstration and modelling are; demonstration was an action to support explanation and modelling was a deliberate and planned action. The key distinctions from

observed practice were that modelling was slower and interactive, as she asked questions at each stage. She implied that she made deliberate mistakes in order to get children to spot the problem and provoke cognitive conflict. Ellie, like Caz, involved children in her modelling. She showed her class, with their help, how to do something, rather than just 'telling' them. The verbs to show and to tell are used in the literature similarly (Weber et al., 2008), but Ellie and Caz make a distinction; they both see the involvement of their children as part of the modelling process.

Gary saw demonstration as a strategy that showed children a worked example, whereas as modelling was to explain best practice, desired presentation or efficient method. He said *I think you probably do more modelling in literacy maybe. I think to demonstrate you are just doing it... whereas modelling would be where you are doing the best way of getting to it*. In relation to one observed lesson he explained he was *demonstrating modelling how to do them* (finding the middle number of two three digit numbers). This was an interesting use of both words in which he saw modelling as where the teacher presents best practice – not only how to work something out but also set it out efficiently - and demonstration as simply showing children how to do something. He did not mention children's participation with respect to either process but indicated that he asked children to explain their thinking. However, observations did not support this belief, as he was seen to explain everything himself in ways typical of an English approach to teaching (Hattie et al. 1996).

To summarise, all four teachers believed that explaining is an important strategy in teaching, even though they do not explicitly articulate that fact, and all believe they involve the children in that process. When comparing practice, however, a significant difference is that one group, Caz and Ellie, deliberately involve their children in the process, whereas the other group, Gary and Fiona, are adamant that their role is to do the explaining as no one *can* do it as well as them. They use the correct vocabulary and show how to set out work to get the right answer. What is intriguing is that these latter teachers found mathematics unproblematic as children, learning and enjoying the acquisition of procedural competence based on a 'how to...' approach. It was this aspect of mathematics they enjoyed, they knew how to 'do it', practised it and became proficient at how to do it. The former group emphasised learner autonomy in their encouragement of students to play around with ideas. They believed a teacher's role is to explain *why* they are doing things and the connection between current and other work they do. I think this element of their practice

presents us with a clear connection between beliefs and practice, as Thompson (1984) and Beswick, (2005) assert, that draws on teachers' experiences as children. All four teachers met and enjoyed school mathematics, two as *instrumental learners* and two as *relational learners*. They present mathematics, and possibly all subjects, in ways not dissimilar to how they experienced it at school; they seem to see their role as developing learners who see mathematics just like them.

#### 9.2.2.4.2 Explaining as prompting and telling

This section is included because one teacher, Fiona, emphasised this strategy consistently. It could be argued that because she worked with young children this strategy was used more than if she had worked with older children. However, there is nothing to be found in the literature that supports this notion. She talked about how she prompted children when they got stuck during whole class phases. For example, she would begin to count to help children if they got stuck when counting, implying that this reflected an approach to scaffolding children's understanding. This *prompt* or *telling* sometimes presented itself as a specific gesture. For example, when adding two numbers ( $5 + 4$ ) together, she would gesture with her right hand as if she were holding the number five in her hand before placing it inside her head, saying 'five' (goes in the head) and then counts with her fingers '6,7,8,9' (adding on four more). Her children are expected to copy her. This strategy is something she uses regularly '*I taught them that strategy. I think that's one of the easiest ways of counting on so I always stick with that strategy*'. Such approaches, increasingly documented in the pedagogical research, show that gestures are especially helpful in the development of formal language (Arzarello, 2006), especially as they provide more cohesive communication than the spoken word on its own (Alibali & Nathan, 2007). Indeed, her children were seen to respond to the dramatic gestures, supporting Fiona's belief that her use of gestures supports young children's learning.

Of course, Caz, Gary and Ellie were all seen to gesture. However, they neither discussed nor were seen to exploit them in a systematic or articulable manner. This distinction could be a result of Fiona teaching young children and a tendency towards a more expressive dimension, but little is written about this in the literature. There is some evidence that the use of gesture in mathematics teaching (see Edwards, 2009; Radford et al. 2007; Roth & Thom, 2009) as well as in other subject fields such as science (Kearney, 2004) and inclusion (Salind & Salinas, 2003), tends to be focused either on the development of students'

expressive skills or the provision of different communicative channels for children with specific learning difficulties (Salind & Salinas, 2003).

#### 9.2.2.5 Visual aids, resources and images used

Ellie and Caz used a range of resources to support their teaching. These included small white boards, post-it notes and small individual clocks. Both teachers viewed resources as tools to assist thinking, including the use of well-rehearsed dances to support recall of the number system, as in the use of a little 'jig' in the style of 'Saturday night fever' that involved children shooting their hands into the air as they chanted the next number in a sequence. For Caz, mathematical learning included fluency; she was very clear in her distinction between the learning of new concepts and the practising of skills derived from that new learning. Procedural fluency, as described by Kilpatrick et al. (2002), was high on her list of objectives. Both Caz and Ellie frequently demonstrated how primary teachers can respond to children's needs in the moment. That is, decisions made by teachers that are not planned for but confidently reflect a secure PCK (Shulman, 1986), where a scaffold, support or simply an iconic image (Bruner, 1986, Bruner & Olsen, 1978) is provided when needed.

Fiona emphasised the use of visual aids and practical equipment to support her teaching. She was observed to use many kinds of practical equipment. These included, for example, a metal money box to 'visualise' the counting of coins with their eyes closed. She also used cupboard items brought in from home to examine properties of solids. However, the extent to which this was undertaken with due care to the integrity of mathematics varied as, for example, she used the peanut butter jar shown in figure 9.5 as a representation of a cylinder.



Figure 9.5: Peanut butter jar

In this respect, the relation between formal and informal meanings has provoked debate. Some researchers encourage teachers of young children to exploit informal language to facilitate their articulation of their ideas, even if they are not mathematically correct (e.g. Tsamir et al. 2011). The National Curriculum (NC) (2000) also suggests that 'informal language should be used at first...' (NC 1998, Ma2). However, as Aubrey (1993) concludes,

children bring to school an extensive bank of knowledge which should be developed and encouraged to provide ‘high expectations and a strong support in place for all children’ (NCTM, 2000, p7).

Fiona was regularly seen to use a covered shoe box (similar to that of figure 9.6), which would contain a set of cards, either with questions such as  $7+4=?$  written on them or a number between 0-20. Fiona’s aim was to use this ‘mystery box’ to develop a sense of excitement. She believed it supported an emphasis on children’s self-efficacy and self-confidence in mathematics (Bandura, 1993; Pajares, 1996). Unifix® cubes to make towers were also used in her teaching of partitioning and recombining two digit numbers. Unfortunately, as discussed above, the cubes confused her children. That said, Fiona emphasised their use as being *enjoyable* rather than as a model of the concept.



Figure 9.6: Covered tissue box

Gary utilised small individual white boards every lesson, believing them to be helpful in increasing the speed at which children work. In one lesson he was seen to use a range of measuring materials, but these were used in a single and very short episode of a lesson on perimeter. Having given his children the freedom to choose whatever resource they wished to measure something in the classroom, he described this as an ‘active’ episode, which he tried to include in all his lessons. Other active episodes, such as ‘brain gym’, were observed in every lesson. He stood at the front and said ‘do this...’ followed by an action. He believed it helped to break up the lesson into *bite-size* pieces so that he can maintain focus and concentration. Otherwise, few materials or resources were observed in lessons, although it could be argued that his ambition for his year five class, preparation for SATs the following year, militated against this.

Evidence suggests that such material can facilitate children’s learning in general and mathematics in particular. They facilitate, for example, learners’ transition from enactive through iconic to symbolic representations (Bruner 1966). Classroom talk, focused on the discussion of such materials, also plays an important role (Liebeck, 1984; Brissenden 1988), as does the guided instruction in their use (Arthur & Cremin, 2010; Gifford, 2004; Siraj-Blatchford, 2002; Pollard, 2008; Thompson, 1993, 2007; Worthington, 2005). The evidence

of this study is that all four teachers believed in the value of such materials and thought of themselves as using them appropriately. That said, there were interesting variations, with one group of teachers using concrete resources to support the *fun* of learning mathematics, while the other emphasised the ways in which good resources can support new learning of mathematical concepts.

#### 9.2.2.6 Fun

Unlike Caz, Gary, Fiona and Ellie all used the word *fun* when discussing their pedagogical decision making. Caz preferred to talk about her children's enjoyment of mathematics. This is an interesting distinction because, as Schuck (1999) and Moyer (2001) suggest, a teacher's professional rationale will influence their perspective on the role of enjoyment.

Caz talked about engagement and challenge. She spoke of projects involving football league tables or Fibonacci sequence investigations, but talked little of 'fun' in the sense of making the children laugh. Ellie also emphasised enjoyment through the use of mathematical games, believing that children respond well to them. However, Ellie's emphasis was the enjoyment of mathematics and not the social engagement, that is not to say that the class did not laugh together with or at their teacher, but this was never an emphasis made by Ellie; enjoyment for her was in the engagement with interesting mathematics, just as Caz had expressed.

Fiona and Gary by contrast, liked to *play* with their children during lessons. Both pretended that they needed children's help in identifying and then correcting their mistakes. Fiona played the 'devil's advocate', mimicking a child-like voice as she did so. She said she did this

*...because they find it quite funny when I don't know things. And... I do try to make my lessons ... fun for them, because it's nice for them to have a laugh. So that's why I did it like that, rather than just saying right here's a shape what shape is it? That's boring!*

Little was mentioned about the enjoyment children might gain from learning mathematics from a mathematical point of view; the emphasis was consistently on social enjoyment (Moyer, 2001).

Gary also liked to make his class laugh. He said he '*often played the clown*' as it lightened the lesson and helped him judge if children were paying attention. He said he often pretended to do or say something wrong, which was observed in all three lessons filmed. Some children appeared not to laugh on occasions. However, that could have been the result of their not paying attention as, on occasions, he spoke for some length of time with the consequence

that some children seemed to switch-off and miss the joke. He was observed to make children stand up and do movement games, e.g. ‘popcorn’ where the whole class had to sit down or stand up in response to an odd or even number called out. The children would often get muddled and make the wrong action, but he clearly enjoyed making them laugh, and they clearly enjoyed laughing with him. However, as with Fiona, little was said about the enjoyment gained from the learning of mathematics from a mathematical point of view; his emphasis, too, was social.

#### 9.2.2.7 Psychology of learning

This section is included because Caz emphasised repeatedly the role of psychology in her teaching and children’s learning, and although the others did not do so explicitly, there were a number of psychologically-related implications.

Caz believed that teachers should understand the distinctions between long and short term learning and between different areas of learning such as school and home. She believed making connections between different topics in mathematics and other subjects was essential, for example when describing her rationale for using resources and images she said

*I think it's about bringing maths together ... and reducing ... the memory load for children. If every time you do a new topic it's not completely brand new you can make the links to the other subjects (topics in maths) and of course that's how children learn and the brain works it makes links and so perhaps more able children make more of those links that's why those children are more able, so the more you can make those links for the children, I think you even the work load and the memory load.*

Caz often referred to memory or work-load in discussions. Drawing on her undergraduate course, which had given her opportunities to study how children learn from an educational psychologist perspective, she emphasised the value of her understanding of psychology, something she considered to be an essential characteristic of an educator.

Gary talked about tricks and memory exercises, some of which have been reported above. However, neither Gary nor Fiona talked about any influence of the psychology of learning. They referred explicitly to what they had experienced as learners, asserting that memorising and practising procedures had worked for them and so replicated them in their classrooms. Clearly procedural fluency is important as part of the acquisition of adaptive expertise (Kilpatrick et al., 2002), but in these cases observed practice was almost exclusively focused on rote acquired practice of known knowledge. Gary’s emphases were clearly focused on SAT success. Regularly he was observed to stop his class and say, for example ‘They (the SAT

questions) *will be looking for...*' or tell them that '*This is a good way of presenting it ...if you do it like this you will get the right answer and 'they' will see that you know column addition*'. Such directive practices seemed at odds with his espoused belief that it was important for children develop their own ideas and methods of mental calculation. In practice, there was little discussion of alternative methods as he kept the class focused on LO-related tasks.

Although Ellie did not talk specifically about the psychology of learning in the same way, she frequently reflected on how children learn. She had a very flexible grouping, which would not have worked if she did not spend time every day thinking about her children's progress and altering and developing tasks and activities to accommodate these flexible groups.

In summary, the four teachers split again into two groups. Caz and Ellie appear to reflect deeply on the ways in which students learn and, as a consequence, are flexible with respect to their classroom seating arrangements. Flexibility was also apparent in their willingness and ability to change direction during whole class discussions. In so doing they both clearly made judgements, in the moment, that facilitated progression in mathematical thinking learning and understanding. Gary was also in-the-moment flexible, but in a different way. He often became distracted by single children's answers to specific questions. If he saw a child write out (on their WBs) an inappropriate method he would spend time explaining to all children how they should present their calculations. He asserted that he was training them to think about what '*they will be looking for*' (the SATs markers). Practice and training was how he saw his role.

#### **9.2.2.8      Expectation and differentiation**

Mixed ability pairings in WCI was emphasised by both Caz and Ellie. They both used talking partners extensively, offering similar rationales related to their belief that children enjoyed mathematics and learned more as a consequence. They both talked about their schools making deliberate efforts to raise achievement through encouraging staff to engage with new approaches, including more flexible grouping and emphases on talk partners.

Fiona and Gary had only worked in schools where ability was the predominant basis for the composition of groupings, as is current in English primary schools (Alexander, 2009; Pollard et al., 2000). Indeed, neither Gary nor Fiona has experience of grouping children differently or thought to question their SMT's expectations with respect to classroom organisation. Moreover, and Fiona alluded to this in her interviews, it is conjectured that both teachers

and mechanisms introduced by their schools colluded in the creation of low expectations for children from low socio-economic backgrounds based on low prior achievement (Dunne et al. 2007). Indeed, working-class pupils are more likely to be placed in lower sets than middle-class pupils who have the same test results, and that pupils from middle-class backgrounds are more likely to be assigned to higher sets, irrespective of their prior achievement (Dunne et al. 2007).

In summary, little is known about whole class interaction in relation to classroom groupings or, more specifically, pupil pairings, but the evidence suggests that children feel more supported where teachers encourage relationships that allow cognitive interchange and dialogue to reign (Ireson & Hallam, 2005; Mercer *et al.*, 1999; Zajac & Hartup, 1997). In other words, children develop higher degrees of self-efficacy and self-confidence when they consider themselves more valued and not victims of teachers' perceptions of their ability, just as in the classrooms of Caz and Ellie.

#### **9.2.2.9 Assessment**

Every teacher in every lesson was seen to assess children during whole class interaction phases of lessons. Again a distinction between the four project teachers emerged with, on the one hand, Caz and Ellie make and, on the other, Fiona and Gary. Caz and Ellie were never seen to focus explicitly on assessment during WCI phases but the management of learning and progression. Typically this occurred through whole class discussion or paired talk. Gary and Fiona, focussed on practising methods and procedures, constantly emphasised, during WCI phases, their children's attainment levels and targets. That is not to say that Caz and Ellie did not assess, for they talked during interview about the mental assessments they made of individual's progression. The significant difference between the two groups was that Caz and Ellie did not explicitly make the assessment or attainment the focus of the presentation of the mathematics to the children.

Summative assessment also featured strongly in both Fiona and Gary's teaching, as indicated by comments made during and after lessons. Gary, as discussed above, consistently reminded children of impending tests and markers' expectations. It could be argued that Gary is no different from many other primary teachers who are locked into a regime of target setting (Mundy 2010). Indeed, such practices form an increasing component of the classroom norms teachers create and allude to a messy juxtaposition of individual teachers' philosophies, beliefs, knowledge and understanding about what primary teaching is all about

and their role in managing the constraints imposed by agencies both internal and external to their schools (Cummins, 1996; Norton, 2000). In this respect, individual teachers' responses to or interpretations of the AfL and APP requirements will influence greatly how they manage their professional activity, particularly in the light of evidence that the average English child is formally assessed 108 times between their first and last days at school (Alexander, 2009).

### 9.2.2.10 Summary of pedagogical approaches

As shown above the nine pedagogical approaches identified by the analyses have typically, but not always, dichotomised the four teachers, with Ellie and Caz always in one group and Gary and Fiona in the other. Table 9.6 summarises these characteristic approaches.

| PAs  | Emphasised   | Caz | Fiona | Gary | Ellie |
|--|--|-----|-------|------|-------|
| <b>Lesson structure</b>  | Influenced by SMT directives completely following without question   |     | ✓     | ✓    |       |
|  | Autonomous in lesson structure, made own decisions about approaches  | ✓   |       |      | ✓     |
| <b>Questioning</b>   | Asked a range of questions to the class  | ✓   | ✓     | ✓    | ✓     |
|  | Afforded time for the children to think about the questions asked of them  | ✓   |       |      | ✓     |
| <b>Discussion</b><br><br>All teachers believed this was one of the most important approaches they used in teaching | Espoused discussion as a pedagogical approach but not observed in practice: IRF used extensively                         |     | ✓     | ✓    |       |
|  | Used extensively in WCI phases of the lesson to develop mathematical thinking  | ✓   |       |      | ✓     |
| <b>Explaining:</b><br>demonstration,<br>modelling,   | <i>Demonstration</i> and <i>modelling</i> are used: teacher led. Teacher <i>demonstrates</i> and <i>models</i> behaviour |     | ✓     | ✓    |       |
|  | <i>Demonstrating</i> is telling children <i>how to...</i> <i>Modelling</i> is jointly led teacher/child(ren)             | ✓   |       |      | ✓     |
| <b>Explaining:</b> prompting   | Sometimes part of questioning by teacher, teacher will prompt  | ✓   | ✓     | ✓    | ✓     |

|   |  |   |   |   |
|---|--|---|---|---|
| and telling.  | and tell children in order to 'support' them.  |   |   |   |
|   | Important to tell and prompt children  | ✓ |   |   |
|   | Teachers articulate this is part of lead-in questions to progress new knowledge (teaching a new concept) | ✓ |   | ✓ |
| <b>Visual aids, resources and images used</b><br><br>As reported by Boulton-Lewis (1998)  | Resources were seen to be used effectively as a thinking tool, scaffold or support.                      | ✓ | ✓ | ✓ |
|   | Resources were used in a rote manner which neither helped nor supported learning for various reasons.    |   | ✓ | ✓ |
| <b>Fun or enjoyment</b><br><br>Linked to teachers' core beliefs about learning mathematics<br><br>It could be argued that these both appear to directly relate to the teacher's own personal experiences of mathematics as a child. | Fun in mathematics lessons: teachers wanted the children to enjoy their mathematics lesson by having fun | ✓ | ✓ | ✓ |
|   | Enjoyment of mathematics: teachers wanted children to <i>enjoy playing with mathematics</i>              | ✓ |   | ✓ |
| <b>Psychology of learning</b> (Skemp, 1976) . An over emphasis on practise was most significant in two of the four teachers here.<br><br><b>Practising:</b> Linked to teachers' core beliefs about learning mathematics             | Instrumental approach to teaching: an emphasis by the teacher on practising knowledge and methods        |   | ✓ | ✓ |
|   | Relational approach to teaching: teaching and discussing methods   | ✓ |   | ✓ |
|   | Practising mathematics is important  | ✓ | ✓ | ✓ |
|   | Practising was the most important pedagogical approach to learning mathematics                           |   | ✓ | ✓ |
| <b>Expectation and Differentiation</b><br><br>On the one hand, SMTs have different expectations of their teachers in how they differentiate, on the   | Teachers <i>mediated</i> by the influences put upon them   |   | ✓ | ✓ |
|   | Teachers who <i>mediate</i> the influences put upon them   | ✓ |   | ✓ |

|   |   |   |   |   |   |
|---|---|---|---|---|---|
| other the teachers' perceptions of that expectation requires of them (Skott, 2009).   |   |   |   |   |   |
| <b>Assessment</b><br>All teachers in this study assess prior knowledge at the beginning of lessons in WCI phases through questioning and discussion in various forms. | targets, attainment levels and practising for short term improvement, |   | ✓ | ✓ |   |
|   | are focussed on long term mathematical learning and development       | ✓ |   |   | ✓ |

Table 9.6: Comparison of teachers' emphasis in PAs

When examined closely the content of table 9.6 points us towards two key characteristics that will influence primary teachers and the decisions they make during the WCI phases of their mathematics lessons. These, shown in the diagram below, point us towards a notion of professional autonomy as shown in figure 9.1.

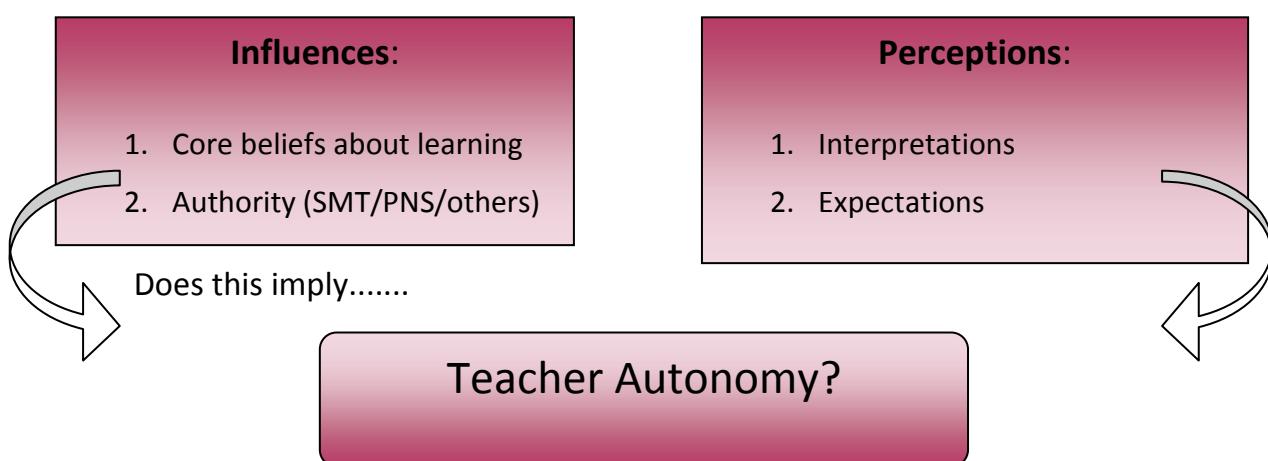


Figure 9.7: Model of Teacher Autonomy components

This idea will be discussed further in the following chapter.

### 9.2.3 Classroom Norms

This section is structured similarly to the previous whereby differences and similarities between teachers' typical practices will be discussed. Importantly, observations, supported by interviews, indicated that each teacher behaved according to well established patterns, thus establishing a classroom norm as described by Yackel & Cobb, (1996). Also, as before, the teachers fall into two groups, with Fiona and Gary in one and Caz and Ellie in the other. Therefore I discuss these group practices against the work of Cobb and his colleagues (Cobb

et al., 1992; Yackel and Cobb, 1996), who introduced the term ‘norm’ to describe the reciprocal expectations that student-teacher interactions establish for classroom participants. Also, as indicated in the literature review, a distinction is made between the *social norms* and *sociomathematical norms* of WCI. That is, for example, ‘the understanding that students are expected to explain their solutions and their ways of thinking is a *social norm*, whereas the understanding of what counts as an acceptable explanation is a *sociomathematical norm*’ (Yackel & Cobb, 1996, p461).

There are three main threads to the discussion presented here:

- **Structural Norms** highlights the lesson structures through which teachers present mathematics during WCI phases. For example, the emphasis made on LOs, success criteria, discussion, and particular peculiarities of whole class phases, time and flexibility.
- **Cognitive Norms** encompass the emphasis a teacher makes to developing children as enquirers and problem solvers of mathematics in general, the precision and fluency procedures, and whether an instrumental or a relational approach to teaching and learning is made in WC phases.
- **Attitudinal Norms** illustrate the emphasis the teacher places on developing children’s confidence, motivation to learning/mathematical learning, enjoyment of learning/mathematics and the teacher’s actions and styles connected to *social* relationships emphasised by the teacher.

### 9.2.3.1 Structural Norms

All four teachers presented learning objectives on their WBs, although, as discussed above, these differed according to which group the individual teacher belonged. In so doing, they exploited routine behaviours familiar to them and their children (Cobb et al. 1992). Caz’s and Ellie’s LOs were broad and, I argue, commensurate with their ambitions that their children should remember the mathematics and not the context. For example increasing the mass of cake sizes by ten, *I want them to remember we were multiplying by 10 and 100 and not learning about cakes!* Both consistently encouraged their children to offer ideas and questions about the learning objectives (*a social norm*). However the manner in which children responded to questions indicated their awareness that there were expected to provide mathematical justifications or reasoning behind their contributions. In short, both Ellie and Caz presented mathematics as a way of thinking and behaving (*sociomathematical norm*) ( Yackel & Cobb, 1996).

In contrast Fiona and Gary spent much time emphasising what they intended to be learnt, with between three and six LOs presented every lesson, meticulously going through each in

detail. Such actions, while superficially mathematical, concerned the establishment of behavioural rather than cognitive patterns of working and so, I argue, reflect a social norm, because they are no more than a ‘telling’ of *what* children are to learn. This is an important distinction and something likely to be hidden from Fiona and Gary, who believe an effective teacher is one who ticks off each of a series of ‘teaching skills’; *go through learning objectives with the class – tick. Go through the vocabulary – tick.* It is not wrong it is simply reflective of instrumentally- rather than relationally-focused beliefs.

The introduction, at a national level, of success criteria in primary education stemmed from Black & Wiliam’s (1998) work on *Assessment for Learning (AfL)*. Their ideas were taken and developed by schools and local authorities’ assessment advisors. In particular, Shirley Clarke, who adapted AfL ideas for the primary setting (Clarke 2003a, 2003b), had become so well known that she became synonymous with all AfL initiatives. Indeed, all four project teachers knew of her and some had received her training. The PNS had also endorsed her work with many AfL ideas being ‘rolled out’ through their curriculum development publications (DfES, 2003b) and subsequent training.

One of the differences between the project teachers lay in their interpretation of this set of ideas, despite the uniformity of training they, or their schools’ representatives, had experienced. In this respect, Black et al. (2002) showed that different teachers adopt and adapt different practices consistent with their understandings of effective teaching, just as Ernest (1989) Thompson (1984) and Beswick (2005) found. They argue that teacher beliefs about their own learning, student learning and agency underpin the way AfL becomes embedded in classroom practice. Moreover, Cooper & Cowie (2010) assert that the promotion of learner autonomy lies at the heart of AfL and if ‘teachers don’t appreciate this it appears that AfL can be implemented as a series of ritualised teaching strategies and hence loses much of its efficiency’ (p980). This assertion is echoed in other studies such as Lee & Wiliam, (2005), Marshall & Drummond, (2006), with Sadler (1989) emphasising the relationship between belief and practice more strongly. Thus, simply displaying and describing success criteria do not ensure quality of teaching; quality in success criteria is discussed through teacher modelling, self and peer assessment of the different examples and how well they meet the success criteria (DfES, 2004).

Interestingly, neither Caz nor Ellie did read through lists of success criteria with their class, preferring to use WCI discussion to promote learner autonomy through understanding,

enquiry and argumentation in their classrooms. On the other hand Fiona used ‘steps to success’ or ‘successful snake’, both school directives, as part of her espoused and enacted presentation and explanation of lists of what is to be learnt, expecting children to read, digest and understand. Similar patterns were identified in Gary’s lessons, where success criteria had become ‘top tips’ for learning successfully. He believed, like Fiona, that it *is good to have a nice... big full board of information. The success criteria need to be quite short and snappy*. So ingrained is this pattern of working, this social norm, that his children had learnt, as discussed above, that the answers to almost all the questions Gary asked could be found in the lists. As Gary commented in respect of his LOs and success criteria,

*if they haven't got that in their head then, looking at the board ... look at it, look at it, yeah that's what we're gonna be doing, remember, remember, remember, and they shouldn't need to look back at that but it's there in case they need it.*

His emphasis is the development of *social* and not a *sociomathematical norm*.

Discussion was managed in different ways. For Ellie and Caz discussion frequently included paired talk, ask the teacher and ask each other questions, think and make connections between the mathematics and between the mathematics and real-life experiences, as described by Boylan (2004) and Weber et al. (2008). Gary and Fiona typically followed an IRF format (Sinclair and Coulthard, 1975, English et al. 2002). The manner in which this played out varied, for example, discussion in Gary’s classroom was quick with rapid closed questions answered by selected students. In Fiona’s classroom the tendency was for her to *collect* several answers before declaring the correct one at the end of the exchange. In her classroom the *social norm* was for children to sit quietly on the carpet in front of their teacher and listen. They played teacher-led games their tasks were explained but very few *sociomathematical norms* were observed that privileged the mathematics above a social behaviour.

To summarise these differences is to acknowledge that children develop learnt behaviours as either autonomous or dependent learners. Autonomous learners appear keen, engaged and eager to learn; they ask their teacher questions and offer their ideas even if they might be wrong. They talk about their mistakes and misunderstandings publicly. Dependent learners are quiet, essentially passive, but highly attentive to their teacher. Gary stands at the front and conducts a fast sequence of closed questions that must not be missed or you will be lost. Fiona sits at the front and conducts discussion through games and extensive

explanation requiring all children to listen hard. In these differing ways, all four teachers collude, through the establishment of particular normative behaviours, in the construction of different forms of learner.

### 9.2.3.2 Cognitive Norms

Games were played in all project teachers' lessons, and in particular the OMS was predominantly presented as a game. Caz used, for example, speed against the clock games for recalling facts and dance and paired games to develop calculation strategies and vocabulary. For Ellie, games were the means through which children talked to develop their subject knowledge and vocabulary. She said they *really enjoy playing those sorts of games* (competitive pairs). *They make it really hard for each other too* (with their questions). *They want to be challenged and be challenging don't they!* The emphasis for using games by both teachers was to make their children think talk and plan their strategies to win thus providing an opportunity to behave mathematically (*a sociomathematical norm*).

Although Gary and Fiona also used games their rationales for so doing were different. Gary frequently used structured tasks, such as writing out times tables frontwards and backwards, which he described as games, during periods of transition. He commented that they filled time while waiting for children to prepare for the lesson. In this instance, his justification was that of time filler (*social norm*) and not a *sociomathematical norm*. At other times he exploited a game called 'popcorn', popular among primary teachers, whereby he calls out a number and, in one variant of the game, children sit if the number is odd and stand if it is even. He varied so to try to catch children out and, in observed lessons, children seemed to enjoy the activity. Interestingly, Gary spoke about breaking up of the lesson, *to get a bit of movement going, we even go into the millions of whole number, just associating a bit of quick thinking ...that's an even number, I need to stand up, odd numbers oh I sit down*. In such an account we can see a *social* rather than *mathematical norm*. Fiona saw a key aspect of her teaching as encouraging children to have fun. Consequently, many of her whole-class activities, like the use of the covered tissue box containing different questions, were presented as games and children appeared to respond to these very positively. Her use of puppets was seen by Fiona as game-like but, as with Gary, emphasised *social norms*, not mathematical.

Finally, the use of active movement activities in mathematics lessons has been seen regularly in primary classrooms since the introduction of the Brain Gym phenomenon. Some schools

introduced these ‘pseudoscience’ (Geake, 2009) activities as part of their daily routine after teachers had attended courses on the approach. What appears to have happened now is that teachers have abandoned some elements but retained others that they believe their children enjoy and benefit from. Certainly the project teachers have included some elements of the ideas into their classroom norms. Caz used a ‘dance’ routine to recall number facts and often went outside to do mathematics. She commented that it helped children’s memory and recall. Fiona talked often about *brain breaks* as in when she used a set of cards containing instructions which she read out for children to follow; place your hands together, extend your index fingers and draw different sized circles in the air. She said that

*it's something I like to do in the classroom as I know they had been sitting down for a long time. They needed to stand up and become a bit more active. So I didn't lose their focus completely I wanted them to have a brain break from it.*

Gary also asked children to stand up and move around as part of his repertoire. For example, after every OMS he asked children to stand up and play a game similar to the well known *Simon says*. He believed these activities were essential for classroom management purposes as they refocused children for learning. Both Fiona and Gary emphasised *social norms* here, whereas Caz and Ellie emphasised a *social mathematical norm* related to memorising facts to recall through association of movement. It could be argued the popcorn game is similar, yet the emphasis is on catching children out.

#### 9.2.3.2.1 Thinking time

All teachers develop routines and rituals that children come to know (Ball, 1993; and Lampert, 1990) and two such rituals, concerning *thinking time*, emerged from the data. One group of teachers provided short opportunities, typically between three and seven seconds, for children to think about a question before answering. The other group provided several minutes for discussion through whole class or paired talk. Such distinctions typically permeated the lessons of each group.

Gary, by his admission, liked to work at a fast *pace* during WCIT phases. He believed this to be unproblematic as this was his style of teaching. Indeed there are frequent indicators in the official documentation (DfEE, 1999, DfES, 2003; OfSTED, 2005, 2006) that a fast pace is necessary during direct teaching. The confidence of the official version of pace is at odds with the literature. For example, Alexander et al. (2000) write that ‘an observer may be

deceived into concluding that pace of classroom talk equates with pace of pupil learning' (p430), while Sangster (2006) adds that it is a pointless exercise if it is not appropriate.

There has been some discussion in primary education about what *pace* means, (Boaler, et al. 2000., Cazden, 2001., Penn, 2002., and Sangster, 2006) and the effect of pace that is too fast or too slow. What emerged from the case studies is that Caz deliberately quickened the pace, for what she described as cognitive reasons, to recall facts. She believed that increased pace was needed when children are learning something new. They

*put a lot of time into thinking about it... when they can do it they are putting less thought into it each time ...so I want them to get ...quicker because then I think they are thinking quicker about it. And the quicker they can do this the quicker they can work with more complex ideas.*

She saw it as a technique for progressing developing in mathematical knowledge. This contrasts with Gary's rationale, where a fast pace meant learning tricks to memorise facts.

The belief of all four teachers, quite naturally, is that they do what they do because they believe their approaches are effective and educationally beneficial. Yet the research into WCI phases of mathematics lessons (Ball, 1993, Lampert, 1990, Alexander, 2000, Alexander et al. 2008) indicates otherwise. Admittedly, there were similarities in all four teachers encouragement of mathematical thinking through gestures, prompts and other movements, but one group saw such actions as prompts for reconstructing number facts, while the other as a means to support children's recall of the same thing. Again a distinction can be made between how teachers create *sociomathematical* norms and *social norms* in their classrooms.

In conclusion, the pace and the relationship to the amount of thinking time given to children dichotomised the four teachers. Although the time provided for thinking reflected a *social norm* in each classroom, the conceptions presented by each teacher highlighted differences in mathematical emphases. The time given by one group for children to co-construct mathematical answers within 'talk pairs' or whole class communities, which Mercer (2008) and Alexander (2008b) argue are effective for learning, was considerably different from the observed practices of the other group.

### **9.2.3.3 Attitudinal norms (Enjoyment - mathematically or socially?)**

When Ellie and Caz, as mentioned above, emphasised their desire for their children to enjoy mathematics, they did so in relation to their structuring their children's learning of

mathematics. It was a psychological tool rather than end in itself. Consequently, their ambitions reflected a *sociomathematical* rather than a *social norm*. Gary and Ellie, however, discussed enjoyment in very different ways. While it could be argued that their desire for their lessons to be fun helped to maintain their children's focus and concentration, they believed that enjoyment of mathematics would lead to success and increased confidence, as with Skott's (2009) teachers. Gary spoke of how 'target children' were asked lots of questions to build their confidence, while Fiona talked about building confidence through positive feedback in question and answers phases. Frequently, for example, she would say things like, *oooh that was a very good answer* or *good girl* or *good boy*. Such actions reflect a *social norm* (Yackel & Cobb, 1996). A justification for their actions may lie in the fact that both Gary and Fiona, for different reasons, paid great attention to the children they perceived as weak. Gary was focussed on progressing all his class two sub-levels in their curricular assessments and so worked hard on those at the margin of that. Fiona was conscious of the low socio-economic catchment from which her children came. Such beliefs and related actions resonate with the findings of Thompson (1984) and Stigler & Hiebert (1997).

One of the ways in which both Gary and Fiona encouraged fun was, quite simply, to make children laugh. Gary called himself the 'class clown', a role he clearly enjoyed. He frequently joked or said funny things just to draw a response. Sometimes this was managerially focused, as when he wanted to see who was listening. On other occasions he would demonstrate a method wrongly. He often teased some of his children and his children seemed to enjoy this light hearted approach. Fiona also believed that making children laugh would build confidence. She did this through her use of puppets, particularly Successful Snake, who often got things wrong in order that children would be able to tell him off and correct him. Fiona, like Gary, frequently pretended to need her children's help with something, as when she asked them to name the shapes of some of her shopping items as she had forgotten them. Typically children were observed to respond well to these interactions with their teacher.

What appears to have emerged from the data is that the project teachers draw on their core beliefs about teaching and learning, attending to what they believe is important in their role, just as the participant teachers in Skott's (2009) study. For one group it is the enjoyment of mathematics (a *sociomathematical norm*), for the other it is to enjoy yourself whilst in class

(a *social norm*). What is important here is that both groups advocate the enjoyment of learning but that the advocacy is differently focused.

#### 9.2.3.3.1. Motivation

All four teachers used a range of strategies to continuously motivate their class during whole class teaching. Ellie appeared to do this less often than the other project teachers, but she was working in an affluent village school with high expectations of all students' engagement. The most significant emphasis by Ellie could be seen in her regular encouraging comments to individuals struggling with the current whole class-related activity ...*that's a good idea*, ...*well done, you are thinking really hard there*. She was also observed to talk to individuals after the end of the whole class phase. Caz was observed to do similar things and, even though her school was in a low socio-economic area, was adamant that all her children were keen to learn and believed she provided them with enjoyable activities to support their enthusiasm. Occasionally she changed task mid-lesson and, for example, instructed her children to play a game in pairs instead of individually. On another occasion she invited children to name themselves John or Edward after the twins on the X-factor TV programme that children were constantly talking about, commenting that

*it just makes it more fun. You are doing exactly the same thing, ...for the children it ...makes them smile and relaxed ready to do what you've asked them to do without them feeling any fear of maths, because they're thinking more about John & Edward for a second. It's distracted them.*

For the other group of teachers motivation was manifested in comments of encouragement like *good girl* and *good boy* and inappropriate superlatives such as *fantastic* and *excellent*, in response to correct answers or behaviours. Facial expressions, too, controlled behaviour, as in encouraging children to speak, get the 'right' answer (the one the teacher was looking for), stop talking, or pay attention.

Fiona's view echoed that of Boaler's (1997) teachers, who believed it was harder to motivate low ability pupils; her role, therefore, was to motivate children socially through ensuring her lessons were not *boring*. She purposefully included activities in the OMS with different objectives from the main body of the lesson, as, in contrast to the belief espoused during her initial interview, she believed this was an effective method to keep children's attention. Although she used songs and rhymes often, her rationale concerned motivating children's engagement with mathematics. This contrasts with the widely held view in Early Years'

circles that rhymes and songs underpin learning and are not solely about motivation (Greenes et al., 2004; Clements & Samara, 2009).

#### 9.2.3.4 Summary

The various issues raised in this section on classroom norms highlight important similarities and differences between case study teachers' beliefs and practices, which, for ease of comparison, are presented in table 9.7.

| CNs  | Emphasised  | Caz | Fiona | Gary | Ellie |
|--|---|-----|-------|------|-------|
| Structural classroom norms<br><i>What basis teachers make decisions about time constraints and flexibility</i> | <i>Sociomathematical</i><br>Quick pace to improve mental agility<br>Flexible lesson structure   | ✓   |       |      | ✓     |
|  | <i>Social</i><br>Quick pace to improve lesson<br>Nonflexible ( <i>do as instructed</i> ) lesson structure   |     | ✓     | ✓    |       |
| Cognitive<br><i>Issues appear related to a teacher's knowledge and understanding of how children learn.</i>    | <i>Sociomathematical</i><br>Awareness of learning theories<br>Affordance & constraints of thinking time   | ✓   |       |      | ✓     |
|  | <i>Social</i><br>Awareness of rhetorical learning experience<br>Superficial time offered to children to think   |     | ✓     | ✓    |       |
| Attitudes  | <i>Sociomathematical</i><br>Enjoyment of mathematics: <i>through providing enjoyable, challenging and interesting tasks, games, the recall of knowledge facts and relationships between numbers and shapes.</i><br>Achievement in mathematical engagement and connections | ✓   |       |      | ✓     |
|  | <i>Social</i><br>Enjoyment of mathematics lessons: <i>children enjoy mathematics through laughing together</i><br>Achievement ( <i>accomplishment</i> )   |     | ✓     | ✓    |       |

Table 9.7: Comparison of Teachers' emphasised CNs

Several striking differences between the two groups emerged. Firstly, with respect to *structural norms*, the findings of this study show that pace, within WCI phases, remains a

contested issue; *what is an appropriate pace during WCI phases and how do teachers know if they achieve it?* (Boaler et al., 2000; Penn, 2002; Sangster, 2006). Importantly, interpretations of pace reflect an earlier discussion that some teachers *mediate* the influences on them, while others are *mediated* by them. With respect to *cognitive norms*, two forms of teacher were identified. On the one hand were teachers whose objective was to challenge children through dancing and rhythmic chanting to develop speed and fluency in enjoyable ways that facilitate new learning. On the other, were teachers who believed that if lessons are chunked into parts, with much movement and arm waving, children would concentrate for longer, be more motivated and, therefore, enjoy improved achievement. Finally, with respect to *attitudinal norms*, a distinction was made between teachers who encouraged enjoyment to provoke a joy of mathematical learning and those who encouraged enjoyment for, essentially, enjoyment.

To summarise, the classroom norms illustrated in these four classrooms seem in accordance with individual teacher's core beliefs about learning, as found by Skott, (2004). What is of substantial interest, and an appropriate site for future research, is the clear distinction between two teachers constantly encouraging social norms and two teachers encouraging sociomathematical norms. The one group, emphasising social norms (Yackel & Cobb, 1996; Mottier Lopez & Allal, 2007) focus on the achievement of particular behaviours which just happen to be in mathematics, not the mathematics itself. The opposite reflects a more relational learning that is created through *sociomathematical norms* that encourage a collective, co-constructed learning which is rooted in mathematical learning (Vygotsky, 1962, Wenger, 1998).

### 9.3 Conclusion

All four teachers were not only considered to be strong mathematically - mathematics specialists and/or leaders - but also (according to local definitions) effective teachers of primary mathematics. Yet two distinct groups of teachers have consistently emerged through the three themes, MI, PA and CN, of this study, which seem to confound the teacher typology proposed by Askew et al.'s (1997), if not extend their ideas of what an 'effective teacher' is. Other studies (Fennema & Franke, 1992; Ma, 1999; Rowland & Ruthven, 2011) highlight the importance of mathematical knowledge as the basis for effective teaching; yet despite the fact that all these teachers are well qualified primary mathematics teachers, there remain substantial differences between them with respect to how their subject

knowledge plays out in classroom. Such differences reflect the findings of earlier research (Ball & Bass, 2000; Shulman, 1986, 1987; Skemp, 1976) concerning differences in teachers' pedagogical content knowledge or particularly privileging of relational or instrumental knowledge.

This study indicates that what transpires during the whole class interactive phases of a lesson is far more complex than a simple analysis of subject knowledge can reveal (Yackel & Cobb, 1999; Skott, 2009). Teachers draw on core beliefs about mathematics and mathematics teaching (Thompson, 1984; Ernest ,1989) that are frequently immune to change (Garmon, 2004; Handal & Herrington, 2003)

There are many influences on teachers during the WCI phases of their lessons. It is only when they are asked to describe what they believe they are doing, and their rationale for so doing, can insight of value be gained. The findings of this study, as manifested in the two groups of teachers, suggest qualitatively different teacher characteristics. On the one hand are teachers who behave autonomously; teachers who mediate the constraints within which they work. On the other hand are teachers who appear dependent and are mediated by the constraints within which they work. Of course, this is a simple summary that belies the layers of complexity of what an individual teacher chooses to do in any given set of circumstances. This will be discussed in the next chapter.

### Chapter Overview

In the first phase of the study, the characteristics of the two teachers, Beth and Abbie indicated two distinct typologies of teacher belief and practice. These were reflected in the ways in which the beliefs and practices of the four main study teachers played out. Inevitably, there were similarities between all six teachers, but the differences, as highlighted in the summary tables of the previous chapter, form the basis for my attempt to theorise what I have found. The two groups have been labelled: the Mediators and the Mediated.

- The *mediators*: teachers who appear autonomous and mediate the constraints within which they work.
- The *mediated*: teachers who appear dependent and are mediated by the constraints within which they work.

But first, I remind the reader that all six participants were mathematics coordinators, trained mathematics specialists or leading mathematics teachers and deeply inducted into the expectations and practices of the PNS. Thus bearing in mind the uniformity of the PNS, few differences were expected.

### 10.1 Differences in the two groups' mathematical intent (MI)

In the following table a summary of the evaluation of the ways in which project teachers' MIs play out.

| Mediators   | Mediated  |
|---|---|
| <b>Mathematical Intent</b> during WCI phases of mathematics lessons   |   |
| <b>Prior knowledge</b> is activated throughout the lesson through consistent reference to known knowledge (mathematical, subject, real-life)            | <b>Prior knowledge</b> is activated at the beginning of every lesson to remind children what they were doing previously |
| <b>Connections</b> are made explicitly and implicitly, and children are provided with opportunities to think about and explore the implicit connections | <b>Connections</b> are made implicitly with little opportunity to develop the ideas                                     |

|   |  |
|---|--|
| <b>Vocabulary</b> is emphasised by the teacher and children are expected to use it in the opportunities they provide through games and other activities | <b>Vocabulary</b> is emphasised by the teacher and children are expected to use it when asked questions during WCI phases                                    |
| <b>Mathematical Reasoning</b> is developed through opportunities provided to think and play with ideas with others and individually.                    | <b>Mathematical Reasoning</b> is developed by learning facts through memorising games and tricks.  |
| <b>Mathematical tasks</b> are provided for children to learn what it is to be a mathematician; playing around with the ideas and discussing with others | <b>Mathematical tasks</b> are performed during WCI phases by the teacher so that the children know how to do the task they will be asked to do individually. |

Table 10.1: MI differences between the two groups

In table 10.1 a summary of the two groups' MIs is presented. In this respect two issues, which distinguish the mediator from the mediated emerged. These were:

1. The teachers' perceptions of mathematical learning, which appeared to be strongly related to
2. The way they encouraged children to engage with mathematics in either a deep or shallow manner.

### **10.1.1 Teachers' perceptions of mathematical learning;**

Obviously, notions of teachers' beliefs on practice are not new. Many researchers have emphasised the importance of beliefs having a direct consequence on mathematics classroom practice (Thompson, 1984; Pajares, 1992; Beswick, 2008 and Aquirre and Speer, 2000). What is not well documented is the influence on both beliefs and practice, in this case MI, of teacher's early mathematical experiences, family influences and predispositions.

The dichotomy in MI in practice cannot be explained by the two groups' primary teacher training as all had followed a professional course of pedagogy and most, four of the six, had not only completed the same educational degree course but also specialised in mathematics. They were of similar age and had probably been taught by the same tutors. Consequently, little can be explained by their professional training, although evidence suggests that much can be gleaned from an analysis of teachers' early experiences of mathematics and the attitudes developed therein.

The mediators talked about the high status of the subject in their families where often it was one member of the family who believed the subject to be important and engaging. Although there were differences in these familial relationships, for example for one teacher it was her grandfather and for another her father, the influences of these family members was significant in the construction of their early mathematical engagement. All remember playing with and identifying patterns within the number system. The mediated teachers also reported enjoyment in early school experiences of mathematics but for them this stemmed not from seeing patterns or structures in numbers but from learning tricks, practising new instructions and feeling the pleasure of getting pages of ticks in their books. Therefore, an understanding of teachers' early experiences may have significant implications for research into teacher efficacy. For example, when Askew et al. (1997) proposed that effective teachers were connectionist they also alluded to the significance of other factors like teachers' predispositions, family influences, and involvement in CPD programmes. The findings of this thesis, while indicating little with respect to teachers' engagement with CPD, highlight well the significance of both predisposition and family influence.

#### **10.1.2. Teachers encouraged children to engage with mathematics in either a deep or a shallow manner.**

Obviously, notions of deep and shallow mathematical knowledge are not new. What is new is that while the teachers of this study are considered by their peers to be effective they fall into well-defined dichotomous groups. All six project teachers were, against local and national expectations, well qualified with good degrees in primary or early years' education and/or development psychology. Yet the expectations of the two groups of teachers in terms of children's engagement with mathematics were very different.

Research, in various forms, has shown that a deep and connected conceptual understanding is the primary marker of a good mathematics teacher (Shulman, 1986; Ma 1999; Rowland and Ruthven, 2011). Effective teachers know how and where this knowledge fits into the bigger mathematical picture and such issues highlight well the distinctions between the mediator and the mediated teachers of this study. The mediators, in terms of both classroom observations and espoused beliefs, emphasised consistently this sense of deep connection, something the mediated teachers did not. So, acknowledging that one of the most significant obstacles to children's learning of mathematics is the poor understanding of the teacher, what can we conclude about the project teachers?

The mediating teachers emphasised children's deep engagement with the mathematics of a task, whereas in contrast, the mediated teachers, appeared to be content with a shallow engagement with tasks. It could be argued that some tasks only provide a superficial level of mathematics so what makes these teachers' practice so different? The field has established that good subject matter knowledge, SCK and PCK (Shulman, 1986) are essential for effective teachers of mathematics, although some will argue its sufficiency (Watson and Barton, 2011). Indeed Ruthven (2011) argues that the problem of subject expertise in teaching is just one component of a much larger issue of the social reproduction of mathematical knowledge, and may be directly related to the asymmetry of teacher and student roles in classroom mathematical activity. In this respect both groups appeared to encourage children to reflect on their learning, but differed by the level at which they expected them to do this. This was also apparent in their own reflections discussed in the SRIs.

On the one hand the mediators demonstrated a strong, non-conformist perspective on long-term goals, ambitions and philosophy for the children they teach. Reflecting a deep understanding of the subject where the quality of both their substantive and syntactic knowledge (Schwab, 1978) allows them to critique the *received curriculum* (Andrews, 2011) in which they work. On the other, the mediated focussed on a pragmatic 'how to...' approach to mathematical knowledge, accepting and providing a conformist curriculum that reflects the current orthodoxy.

Analyses of the two groups highlighted differences in teachers' perceptions of what it is to be a learner of mathematics, and how children can be engaged in deep learning and understanding. Little understanding of these things is encouraged in teacher training courses currently, partly because little opportunity is provided for beginning teachers to analyse their own psychological and sociological perspectives on how they learnt mathematics themselves, or, indeed, how children learn early mathematics. I will discuss the implications of this further in the next chapter.

## 10.2 Differences between the two groups' Pedagogical Approaches

The second category to emerge from the analyses concerned teachers' pedagogical approaches and the methods they emphasised during the WCI phases of their mathematics lessons. Again, of the two phase-one teachers, one sits comfortably within the mediators and the other in the mediated as described in chapter nine, which are summarised in table 10.2 below.

| Mediators   | Mediated  |
|---|---|
| Pedagogical Approaches  |   |
| <p><b>Lesson structuring</b> is determined by the teacher's knowledge and understanding about a relational view of mathematics. Teachers are <b>autonomous</b> teachers and draw on their core beliefs about learning.</p>  | <p><b>Lesson structuring</b> is determined by the teacher's knowledge and understanding about an instrumental view of mathematics. Teachers are <b>non-autonomous</b> and heavily influenced by their understanding of what others expect of them (SMT, OfSTED, PNS, parents etc.).</p>   |
| <p><b>Discussing</b> is the engagement of all children where opportunities are provided for <b>authentic discussion</b> to happen.</p>  | <p><b>Discussing</b> is controlled by the teacher where questions are asked and children are often expected to think and answer independently displaying a <b>non-authentic discussion</b> to happen.</p>   |
| <p><b>Questioning</b> of all types were used extensively during WCI phases, this group provided opportunities for the children to think about the questions before being expected to answer</p>   | <p><b>Questioning</b> of all types were used extensively during WCI phases, this group provided very few opportunities for the children to think about the questions before being expected to answer. Often questions were asked to which the children already knew the answers.</p>  |
| <p><b>Explaining</b> was not a word used by the teachers to describe what they did, using it only to describe what they get children to do. When they explain in class they use demonstration and modelling as part of this process. Although unsure of the difference, they settled with the idea that modelling was something that was developed with children and demonstration was them showing children something; likened to 'telling'. The teacher is an expert who guides and extends children's knowledge and understanding, perhaps drawing on core beliefs about learning, emphasising a relational learning approach.</p> | <p><b>Explaining</b> was not a word used by the teachers to describe what they did, using it only to describe what they get children to do. When they explain to their class they use demonstration, prompting, showing and telling. Although unsure of the difference between modelling and demonstration, they settled with the idea that modelling was about showing children best practice, where children listened and watched carefully the 'best' way to do something. Teaching is skill based; the teacher's role is to teach skills, perhaps drawing on core beliefs, emphasising an instrumental learning approach.</p> |
| <p><b>Resourcing.</b> To scaffold learning through using materials as thinking tools to support learning, emphasising a relational learning.</p>  | <p><b>Resourcing.</b> To scaffold learning, the teachers said; however the materials were seen to be used in a rote manner, emphasising an instrumental learning.</p>   |
| <p><b>Practising</b> was seen as part of an approach to learning to develop speed and agility (perhaps <b>autonomy</b><sup>4</sup>?).</p>   | <p><b>Practising</b> was perceived as most important in learning mathematics by this group. The teachers' perception was that this was the how children learned (<b>non-autonomous</b>).</p>  |

<sup>4</sup> The meaning of autonomy will be elaborated and examined later in the chapter.

|   |   |
|---|---|
| <b>Encouraging Fun and enjoyment</b> of mathematics was through playing around with number and shapes to see what can be found out, an exploration of mathematics.  | <b>Encouraging Fun and enjoyment</b> of mathematics was where the class had fun and laughed with the teacher, not necessarily related to mathematics learning at all.   |
| <b>Expectation and differentiation.</b> This group of teachers had high expectations of all children despite school context. Differentiation of tasks was discreet and flexible. They mediated the influences and demands made upon them e.g. PNS curriculum, OfSTED, SMT, parents, attitudes of socio-economic context of cohort and school etc. An <b>autonomous</b> teacher. | <b>Expectation and differentiation.</b> This group of teachers had fixed expectations and differentiation groupings. They were heavily influenced by the demands made upon them e.g. PNS curriculum, OfSTED, SMT, parents, attitudes of socio-economic context of cohort and school etc. They appeared to be mediated by their context. Not an <b>autonomous</b> teacher. |
| <b>Assessing</b> is seen as something the teachers do day to day. Critical reflection was used daily by teachers to understand the progress of their children and how they organised the next session as a consequence.<br>An <b>autonomous</b> teacher.  | <b>Assessing</b> is seen as the most important part of the teacher's role. Summative assessment was needed regularly to inform them of levels of attainment for each child in order to organise the next unit of work.<br>The teachers' perception was that this was the expectation of them ( <b>non-autonomous</b> ).   |
| <b>Psychology of learning Relational learning is emphasised.</b>  | <b>Psychology of learning Instrumental learning is emphasised.</b>  |

Table 10.2: PA differences between the two groups

The pedagogical approaches of all project teachers were defined by the ten components listed in table 10.2 above. These were those most commonly used by project the teachers. However, the manner of their dichotomisation alludes to three teacher characteristics.

1. The extent to which teachers appear **autonomous** decision-makers with respect to their presentation and management of mathematics;
2. The mediators emphasise a **relational** perspective on mathematical learning while the mediated teachers emphasise an **instrumental** perspective;
3. While they may use the same vocabulary to describe their approaches to mathematics teaching the two groups **assign different meanings** to them.

### 10.2.1 Teacher Autonomy

If we accept that 'all mathematical pedagogy, even if scarcely coherent, rests on a philosophy of mathematics' (Thom 1973 p204), then the teaching approaches taken by all teachers incorporate their assumptions about the nature of mathematics, and that any philosophy of mathematics has classroom consequences (Hersh 1979, Steiner 1987). With respect to their MI, the mediators demonstrated that they were aware of and could articulate their mathematical epistemological and ethical frameworks, so it should not be

surprising that they were also able to articulate autonomy in their decisions about their teaching approaches.

Teacher autonomy appeared to be a significant discriminator between the explanations and justifications provided of their actions of two groups of teachers. During the initial analyses it appeared to be the dominant characteristic, but when attempting to describe how notions of teacher autonomy can facilitate the identification of differences, it was found to be more problematic than expected, just as Lawson's (2004) review suggested. He points out that 'the appeal of teacher autonomy to the profession must be tempered by the recognition that it has the ability to both liberate and deceive' (2004, p3).

Teacher autonomy is not well documented in the mathematics education literature yet it occupies a position of widely accepted importance in the professional literature (Alexander, 2004, 2009; Aubrey, 2006) and research in language education, where evidence suggests that learner autonomy, crucial to effective learning, is dependent on teacher autonomy (Cotterall, 1995; and Dickinson, 1995). Moreover, teacher autonomy is dependent on secure subject knowledge (Little, 1995; Merry, 2004; Vieira, 2007; and McKeon, 2004), the importance of the quality of the mediator teachers' subject knowledge in the construction of their autonomy.

More than twenty years ago Ernest (1989) offered a set of attributes possessed by an effective teacher of mathematics teachers; he did not argue that they defined an autonomous mathematics teacher but that they are characteristic of an autonomous mathematics teacher. They reflect the characteristics of the mediators in their facilitating the adoption of a *critical view* on all aspects of practice. Such teachers possess

- An awareness of having adopted specific views and assumptions to the nature of mathematics and its teaching and learning
- The ability to justify these views and assumptions
- Awareness of existence of viable alternatives
- Context-sensitivity being concerned to reconcile and integrate classroom practices with beliefs and to reconcile conflicting beliefs about themselves.

Such attributes, at least as far as this study is concerned, depend upon a teacher's understanding of the learning process, or the image they have developed for themselves of what mathematics learning should be like. In reality, this means that teachers are likely to see themselves as exploiting a range of strategies located on continua between transmission and self-directed student engagement (Cooper and McIntyre, 1995). In such perspectives,

both Ernest (1989) and Cooper and McIntyre (1995), we can recognise the characteristics of the two groups of teachers, helping us to understand how teacher autonomy may be manifested during the WCI phases of a mathematics lesson.

In essence, the mediated teachers displayed few characteristics of the autonomous teacher, and this was reflected in the quality of their justifications for their professional decisions and actions. They believed that what they do is effective because they are compliant and defer to the instructions of an authoritative other, whether these are their SMTs, the PNS or OfSTED. They were also mindful of the socio-economic status of their particular settings and inferred children's abilities from them. This is not a new idea as Skott (2009) also reported on how his participant teachers were more concerned with the low socio-economic status of children and how they expected less of the children as a consequence. Thus, one is drawn to ask whether the school context should be acknowledged when analysing teacher autonomy. On the one hand a school may or may not present a very prescriptive (rigid) system and therefore have an effect on a teacher's autonomy within that working context. On the other hand it could be argued that it does not matter whether working practices are prescribed or not, the issue is whether the teacher perceives them to be so.

To summarise the above I show, in table 10.3 below, how the project teachers were construed to behave in their respective settings. The table shows whether the teacher exploits the opportunity to grasp autonomy or not, and takes into consideration the school social context.

| School Context: <i>influenced by PNS, SMT, socio-economic understandings of children, setting and abilities.</i> | Teacher takes or grasps autonomy | Teacher does not take or does not grasp autonomy |
|--|----------------------------------|--|
| Non-prescriptive system<br>Autonomy given  | Caz<br>Ellie<br>Abbie            |  |
| Prescriptive system<br>Autonomy not given  |                                  | Fiona<br>Gary<br>Beth                            |

Table 10.3: Teacher Autonomy

Although placing project teachers the table may appear straightforward, there are issues that remain unsatisfied by it. It does not allow an individual to be placed accurately. For example, individuals may believe they have no autonomy, due to their perceptions that they

are constrained by highly prescriptive settings, when in fact they are not so constrained. Others may believe they have contextual autonomy, in the sense that they are free to act autonomously within their settings, but feel constrained by systemic directives. The issue here is that teachers' perceptions of their working contexts will influence their perspectives with respect to autonomy. In particular, the evidence of this study shows that some teachers, the mediated group, are confident because they believe they are successful against criteria which, to them, are beyond question because they derive from a higher, and therefore valid, authority. So, maybe the table is less helpful than I had originally thought, a number of studies have alluded to teacher autonomy (Ernest, 1989; Thompson, 1984; Beswick, 2004; Skott, 2009) but assumed that the reader knows exactly what teacher autonomy means. Perhaps an alternative description is needed.

What appears to be more helpful is a continuum, as discussed by Cooper and McIntyre (1995), to represent the different elements of professionalism discussed above. As can be seen in figure 10.1, I have construed the extremes of the continuum as professional independence and professional dependence and attempted to place each of the six project teachers along the continuum. In so doing I try to encompass a teacher's awareness of, views on and assumptions about the nature of mathematics teaching and learning, and to illustrate his or her ability to warrant professional decisions (Ernest, 1989).



Figure 10.1: Professional Independence Continuum.

For example, we know, on the one hand, that Caz warrants her practice against her own learning and understanding of mathematics teaching. She mediates constraints by dint of her confidence in her professional knowledge and skills and is able to work independently of others. On the other hand, Fiona is highly influenced by authoritative others and does not question what she has been asked to do. She accepts uncritically her instructions and follows them. These are professional decisions made by teachers about the constraints placed upon them. For Gary, Fiona and Beth, these constraints appear to be structuring devices for their teaching. For Caz, Ellie and Abbie, constraints are acknowledged but assumed flexible. They

mediate the demands of authoritative others by means of their own knowledge and understanding of mathematical pedagogy.

What is interesting is that while all project teachers were conscious of the varying demands made upon them, their responses to those demands varied. For example, Fiona, Gary and Beth talked about the stressful demands made on them in general and as a consequence of various national initiatives in particular. Gary, for example, commented that *we're fed up with all the changes. Just tell us what to do and we'll do it.* In so saying, he was confirming not only that he wanted to do his best for his children but also that he wanted someone to tell him what that meant so he could get on with it, reiterating his deference to authority. The mediators expressed similar concerns but negotiated them differently. Indeed, the key difference between the mediators and the mediated was in the ways that individuals handle such pressures, teachers who display the characteristics of strong professional independence have the resilience to mediate in appropriate ways the constraints placed upon them.

### **10.2.2. Instrumental and relational understanding: core beliefs on learning**

In table 10.2 differences in the ways that teachers conceptualise their professional roles were highlighted and allude to differences in teachers' core beliefs about learning derived from their own experiences as learners. For example, Gary commented frequently not only on how learning tricks and memorising procedures helped him as a child but also how this justified his practice. In similar vein, the mediated teachers spoke of the importance of attainment goals and assessment as key underpinning components of mathematics learning and teaching. Their emphasis was on limited fixed outcomes through carefully devised 'steps' to facilitate the progression of their children. Such perspectives are located in an instrumental approach to learning, where mathematics is a set of rules that must be memorised, as recognised in Thompson's (1984) study, and where 'habit learning' (Skemp, 1976, p1) is favoured. The mediators spoke about and acted in ways commensurate with relational or 'intelligent learning' (Skemp, 1976, p1). The importance of this particular distinction draws on the fact that 'evidence of being able to do is a partial indication of the presence of understanding but by itself it is not enough" (Duffin & Simpson, 1994, pp. 29-30). Thus, the mediated group, who talked about the enjoyment gleaned through getting pages of work correct, seem to have failed to understand that instrumental success may mask relational failures. Justifying practice on the basis of their own experiences they make

their children dependent on their teacher revealing the next step in the chain of procedures to them. The above offers a plausible rationale for the differences between the mediator and the mediated group's approaches to learning.

### **10.2.3 Differences in assigned meaning to vocabulary: authentic talk.**

Finally, the third component highlighted in the analyses of teachers' PAs concerned their perceptions of classroom *discussion* and children's *enjoyment*. In respect of enjoyment, defined here as *taking pleasure from*, all teachers were observed to motivate their students by means of activities designed to promote enjoyment. However, enjoyment was emphasised differently by the two groups. For the mediators it was related directly to mathematical phenomena, where they set tasks to develop intrigue and a sense of wonder about, for example, the number system. For the mediated group the enjoyment was emphasised socially rather than mathematically. They indicated that enjoyment derives from being in the classroom and laughing together. Although all teachers recognised that mathematics is a challenging subject that many children learn to dislike it is not inconceivable that these enjoyment-related differences stem from differing interpretations of the PNS guidance (DfES, 2003) emphasising that 'enjoyment is the birth right of every child' (Clarke, 2003 pfd).

Discussion was agreed by all teachers to be one of the most important aspects of their PAs. However, individual teacher's understanding of *discussion* appeared to differ greatly. The mediators espoused and demonstrated through practice that talking about mathematics was not only essential for mathematical learning but also in learning to *behave* like a mathematician (Yackel & Cobb, 1996). The Mediated group, despite espousing similar aims, were seen only to work within restricted IRF formats privileging simple answers to closed questions. One key factor emphasised by all teachers was that discussion provided an opportunity for children to use correct vocabulary. However, in practice, only the mediators emphasised the use of correct vocabulary in context. For example, the mediators provided opportunities for children to talk to a partner within, say, the context of a game. Such discussion is well documented in the literature (Flanders. 1970; Alexander, 2000; Moyles, 2003; Ball, 1993; and Lampert, 1990; Pratt, 2006), where it is recognised that a high level of purposeful talk can enhance learning. I call this 'authentic talk' or more specifically *authentic mathematical talk*. As above, I use a continuum, figure 10.2, to show how project teachers exploit talk within the WCI phases of their lessons.

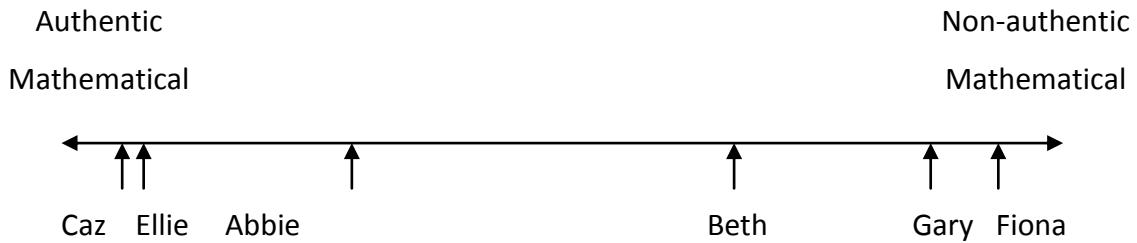


Figure 10.2: Authentic Talk continuum.

The mediators saw whole class discussion as children engaging in and becoming a proficient member of a mathematical community through language; for, as Barwell (2005b) notes, 'learners must learn more than the procedures and vocabulary of mathematics; they must also learn to use the speech genres of mathematics' (p790). In other words, they espoused and enacted the importance of teaching children to learn to speak mathematically (Lerman, 2001). For the mediated teachers, discussion was construed as talk dominated by an IRF format (Flanders, 1970; Lemke, 1990; and Sinclair & Coulter, 1975). Thus children acquired an instrumental vocabulary as they were not encouraged to engage conceptually with it.

### 10.3 Classroom Norms

The table below (10.3) summarises the differences in the two groups' construction of classroom norms. It highlights well the distinction between the mediator teachers' construction of sociomathematical norms and the mediated teachers' construction of social norms Yackel & Cobb, 1996, Yackel et al. 1999; Mottier-Lopez & Allal, 2007; Chazan et al. 2012). Indeed, when analysing the data on WCI it soon became apparent that each teacher displayed regular patterns in his or her practice. These patterns were exemplified through consistent lesson structures, cognitive expectations and the way in which teachers promoted various attitudes towards the subject.

| Mediators  | Mediated   |
|--|--|
| <b>Classroom norms</b>   |  |
| <b>Structural classroom norms</b><br>Support a <i>sociomathematical norm</i> where the focus is about engaging in mathematical learning.   | <b>Structural classroom norms</b><br>Support a <i>social norm</i> where the focus is influenced by individual social problems e.g. behaviour, concentration etc.   |
| <b>Cognitive classroom norms</b><br>Authentic discussion/talk<br>Profound Thinking time: time provided for children to think on their own and with a partner. The emphasis is on <i>mathematical achievement</i> . A <i>sociomathematical norm</i> . | <b>Cognitive classroom norms</b><br>Non-Authentic discussion/talk<br>Superficial thinking time: Little time to think during WCI phases, pace often quick, and an emphasis on <i>achievement</i> in mathematics. A <i>social norm</i> . |

| Attitudes and motivation  | Attitudes and motivation   |
|---|--|
| <p>A <i>sociomathematical norm</i> was emphasised through how to behave like a mathematician. To develop children's attitudes and motivation in mathematics through providing challenging interesting tasks and games and explore connections within mathematics. Developing an attitude that although mathematics is hard, it is an enjoyable intriguing subject to engage in.</p> | <p>A <i>social norm</i> was emphasised through laughing together to make the experience fun not necessarily mathematical. Children's attitudes and motivation were developed through a behaviourist approach where children are expected to sit and listen carefully, where an emphasis on achievement levels and measurable outcomes are prioritised.</p> |

Table 10.4: CN differences between the two groups

### 10.3.1 Behavioural Norms

Structurally, as indicated in the PA section above, the mediators emphasised the development of a mathematical community, where the focus of WCI phases was on mathematical thinking. Conversely, mediated teachers were very concerned with the general behaviour of the class whether, for example, are all children listening to what the teacher was saying. Such differences emphasise how micro-cultures, as described by Cobb et al (1992) and Mottier-Lopez & Allal (2007), develop in classrooms and confirm Chazan et al (2012) belief that 'mathematics classrooms can be conceptualised as spaces of patterned social interaction in which people do school mathematics' (2012, p.1). Confirm thus, a way learning emerges through the dialogue of mathematics lessons (Lampert, 1990) that is framed by a set of behaviours understood and enacted by both teacher and children. This set of behaviours, that structure lessons, influence greatly children's cognitive engagement. The children came to know and understand the behaviours expected of them which, as already discussed, can be *rich* (relational) or *shallow* (instructional) (Skemp, 1972) from a mathematical learning perspective.

### 10.3.2 Cognitive Norms

Many of the differences between the two groups were related to the opportunities teachers provided for their children to think mathematically and whether or not they were expected to engage in *authentic mathematical talk*. As Ball and Bass (2000) and Watson and Mason (1998) note, it is not just about engagement, for all children respond to the questions, prompts or tasks they are presented with, it is in the level and form of engagement that distinguishes the mediator from the mediated. Watson and Mason (1998) describe a teacher's questions and prompts as being effective mathematically when they are based on mathematical structures and thinking. The mediators consistently demonstrated this in the tasks they provided. The mediated teachers talked more about the progression of lessons in

relation to time pressures, for example, not taking too much time over discussing things, as one teacher said ‘so we could move on quick(ly)’.

### 10.3.3 Affective Norms

Finally the attitudes and motivational emphases that the two groups promoted in their classroom norms provided a subtle but nevertheless, fascinating difference between them. All teachers wanted their children to enjoy mathematics, just as they themselves had done as children. However, the mediated, resonant with Kyriacou & Goulding’s (2006) review, emphasises enjoyment of the challenge and the feelings of worth that appropriately challenging mathematics provided, while the other promoted enjoyment of procedural approaches to the learning of mathematics, just as they had experienced as learners.

All teachers believed that the methods promoted in today’s teacher training were better at facilitating children’s learning of learning mathematics. For example, all believed that making mathematics lessons enjoyable meant that children would develop positive attitudes towards the subject, thereby fulfilling what they believed was part of their role as a teacher of the subject. However, the differences were not only in the way *enjoyment* was interpreted, but also in teachers’ understanding of what it means to motivate children to engage in mathematics. The implications suggest that ITE and CPD should develop ways in which new teachers can identify what it is that they enjoy about learning mathematics and develop programmes to challenge deep core beliefs over a period of time.

Project teachers’ beliefs about the role of classroom resources provided further distinctions between the two groups. For example, resources used by mediators were to challenge children’s thinking and facilitate their understanding of mathematical concepts, as seen in Caz’s question, how do you find a quarter of a potato? For the mediated teachers, resources were to provide an element of ‘fun’ or ‘interest’, as in Fiona’s Learning Lion puppet. However, the act of incorporating fun does not, of itself, guarantee learning; too much of an emphasis on a puppet, a box and card may send wrong messages to young learners and skew their awareness of the intrinsic value of mathematics and mathematical learning (Moyer, 2001). Moreover, teachers’ comments can trivialise the use of resources, and to some extent mathematical thinking, in subtle ways (Moyer, 2001). Indeed, the Mediated teachers, who privileged fun, may be unaware of the limiting consequences of their actions, acting ‘as if student interest will be generated only by diversions outside of mathematics’ (Stigler & Hiebert, 1997, p89). CPD and initial training programmes need to facilitate

teachers' reflection on what they privilege during WCI phases of lessons. Is it a trivialisation of the mathematics in order to make mathematics lessons fun? Or is the learning in the mathematics that evokes an intellectual enjoyment of manipulating mathematics?

To summarise, programmes that support teachers' understanding of the desirability of socio-mathematical classroom norms that facilitate students' mathematical engagement rather than an act of routine practising would seem essential. Teachers need to provide opportunities for children to engage with mathematical connections and explore and practise until fluent enough to be able to 'speak mathematics' (Lerman, 2001). Training should provide a theoretical perspective that enables beginning teachers to unravel their own understanding and ideas and match them to what the research informs us are meaningful, effective and enjoyable mathematical experiences.

## 10.4 Conclusions

I will now summarise the key ideas that have emerged and consider the implications of these dichotomies for future research, teacher training and policy making. Three key issues have been identified to inform the research field as follows:

### 10.4.1 Background influences

- The literature indicates that teachers' beliefs about mathematical learning draw heavily on their beliefs about the nature of mathematics; a finding supported by this study. However, this study has found that such beliefs derive from teachers' own experiences as learners of mathematics and the influence of their families. In respect of the latter, these influences were positive for some teachers and not for others. This is a new and unexpected dichotomy which needs to be researched further as there is much research in early years regarding family influences in general, but nothing specifically related to mathematics. This is a new finding for the research field.
- Early experiences in individual's mathematical learning appeared to play a much stronger role in the way in which all teachers understood the nature of mathematics, and indeed why they enjoyed those experiences. Here the dichotomy revealed that the way in which they engaged with mathematics influenced what they enjoyed and how they teach the subject in their own classrooms. Those that played with number relationships, puzzles and logic problems continued to enjoy this creative aspect of mathematics through the way in which they present the subject. Those that enjoyed

a structured and essentially closed approach continue to with their class. Although this is not a completely new finding, the research here presents a new perspective.

- Training was not the same for all participant teachers. However, four participants trained as mathematics specialists at the same institution, during the same period with the same tutors. In essence, all teachers held good degrees and all were considered effective teachers of mathematics. Few differences in their understanding of mathematical subject knowledge were therefore expected. The evidence here, highlighting previously unconsidered issues, provides a new perspective for the field.

#### **10.4.1.1 Summary and Implications**

In summary, the dichotomies indicate that teachers' early experiences and family attitudes influence the ways in which they engage with and encourage children to engage in mathematics. In particular, these influenced significantly, MI during the WCI phases of their lessons, most notably with respect to their privileging of either relational or instrumental learning. The implication for teacher education is that teachers are aware of the impact such experiences can have on their practice and the most obvious place for this would be during initial teacher training (ITE), supported by with specialist mathematics educators with a secure understanding of mathematical pedagogy. Possible application of the research findings are presented in the table (10.5) below.

#### **10.4.2 Pedagogical Practices**

- Discussion was a key component of all teachers' PAs and acknowledged by all participant as an important aspect of their practice. The two groups differed in their understanding of the nature of *authentic mathematical discussion*. One group, immersed in the creation of authentic mathematical talk, provided frequent opportunities for children to discuss with both peers and teacher and time to think. One group provided only extensive opportunities for students to respond to closed questions as part of an IRF sequence. Although the findings are not new to the field, they not only provide further evidence of teachers' awareness of the value of discussion, but also that teachers hold different interpretations of what discussion is. The implication for ITE and CPD is the need for teachers to understand the choices they make and why it is important to afford explicit opportunities for children to engage in *authentic mathematical talk*.

- Teachers induct children into classroom norms. Children come to know and understand the behaviours expected of them. The findings reported here show key differences between participant teachers in terms of whether they create *rich* (relational) or *shallow* (instructional) mathematical routines and practices, and the implications these have on cognitive engagement of learners. The findings indicated that teachers are not necessarily aware of either the norms themselves or their implications for children's learning. Thus, further work in teacher education is necessary.
- A desire for children to enjoy mathematics was espoused by all teachers. What dichotomised them was the way in which they interpreted *enjoyment*. The mediators attended to enjoyment as reflected in the use of creative and playful approaches that introduce children to the wonder of mathematical relationships. The mediated saw enjoyment as an end in itself or a means to manage children's behaviour. Either way, it seems clear that ITE should make beginning teachers aware of such distinctions and of the value of both perspectives on enjoyment.
- All teachers exploited resources in their teaching of mathematics. As with enjoyment, the mediators used them to facilitate children's conceptual understanding of mathematics while the other saw them as part of a repertoire of tools to facilitate participation. That is, for the mediated teachers, resources played little part in children's learning as their explicit intention was motivational. In such ways the use of resources may marginalise the intended mathematical learning outcomes. There is much that could be done through ITE and CPD opportunities to develop teachers' awareness of these distinctive uses and their implications with respect to mathematical learning.

#### **10.4.2.1 Summary and Implications**

In summary, the four implications for ITE identified above are currently being incorporated within my own institution's third year BA (QTS) Education, and the PGCE programmes. In order to develop trainees' awareness of different types of talk a new essay title has been created on talk which will engage our students' knowledge and understanding in the importance of talk for learning. In more general terms, each point will now be summarised in a table (Table: 10.5) to look at possible applications of the research findings.

### **10.4.3 Professional Issues**

- This study has shown how a continuum focused on teachers' *professional independence* can encompass many attributes influential in the ways that teachers present mathematics to children. All teachers were acutely aware of the constraints placed upon them by, for example, their schools' SMTs, PNS directives, and OfSTED. The mediated construed such constraints as the starting point for their decision making and, essentially, accepted all as authoritative. The mediators recognised the constraints as barriers but were flexible within them. This flexibility enabled them to mediate both external and institutional demands by means of the confidence they drew from their knowledge and understanding of mathematical pedagogy.
- Although linked to the above point, frustration with time constraints was apparent in all teachers. However, the mediated, at the *professional dependence* end of the continuum, spoke of being '*fed up with all the changes*'. Although spoke about being undervalued and professionally disempowered, it seemed that they did so because they were unaware that they possessed the intellectual resource necessary to critique and then adapt such constraints.
- Finally, there was a substantial shift in the ways that teachers spoke about mathematics from phase one of the study to phase two, as reflected in a shift towards 'strategy-speak'. Teachers no longer talked about mathematical concepts and the value of good explanations but spoke of interactive teachers that demonstrate and model mathematics. Interestingly, while words like explain seem to have disappeared and been replaced by model and demonstrate, project teachers seemed to use the new words synonymously. Thus, there appears to have been a significant shift in what teachers chooses to talk about, reflecting, it seems to me, a partial induction into a new professional language. Most worryingly, embedded in this new language is a shift from talking about mathematics, its teaching and learning, towards a discourse based on attainment levels, success criteria and performance indicators.

#### **10.4.3.1 Summary and Implications**

In summary, the professional points raised in this section indicate that teachers are increasingly expected to follow rhetoric in order to operate in an increasing politically driven profession, as demonstrated through this study. Some teachers are able to negotiate their own knowledge and understanding of what their professional role is, in an ever changing

and shifting landscape of primary education. But others are not. Yet if given the opportunity to engage in substantive professional development with research informed, educational subject experts, then perhaps teachers will be able to shift deeply held beliefs and attitudes as Beswick, (2012) discusses. The table below (10.5) provides an overview of the possible application of the research findings.

### 10.5 Summary

In summary, while all six teachers would, against conventional descriptions of teacher quality, be construed as well qualified and effective, the evidence of this study is that they differ greatly when evaluated against characteristics indicative of *professional independence*. That is, mediators engage children in *authentic mathematical talk*, and had high expectations that all their children will behave as mathematicians and enjoy the challenge. Those mediated had a different outlook, located in a naïve understanding of professionalism and conformity, whereby children were encouraged to enjoy being in mathematics lessons and experience success by dint of doing precisely what they were told to do. The dichotomisation of these six teachers was unexpected and offers the field new insights with respect to teacher professionalism, particularly in the ways in which three teachers mediated the constraints upon them, while the other three were mediated by the same constraints. The implications for ITE and teachers' CPD will now be summarised in the table below (10.5) to demonstrate possible application of research findings within the professional field.

| <b>Implication to develop trainees' and teachers' development identified:</b> | <b>Possible application in ITE and CPD programmes:</b>   |
|---|--|
| Personal experience in learning mathematics                                   | Develop awareness in teachers and trainees, of how they learnt to engage in mathematics, and what they understand about the nature of the subject. Through ITE, the current MaST programme and the new proposed Subject Specialist Primary ITT Programme (SSPIP) in mathematics. |
| Influences on how they learnt mathematics                                     | Become aware of the influences teachers believe they have on the way in which they operate in the classroom. Through ITE, the current MaST programme and the new proposed Subject Specialist Primary ITT Programme (SSPIP) in mathematics.                                       |
| Authentic Mathematical Talk   | Develop trainee and teachers' awareness of pedagogical outcomes of high level classroom discourse, where opportunities are afforded to children. In an attempt to  |

|   |   |
|---|---|
|   | extend an entrenched perspective of some English primary teachers that still follow more a traditional cultural mathematics classroom experience.   |
| Classroom Norms   | Develop both trainee and teachers' awareness of the types of cultural classroom norms they create in their classrooms and the long-term effect these might have on children's learning. The findings suggest that more opportunities are needed for teachers to reflect on their practices. CPD is essential, which is <i>more</i> than a new procedure (tick list) to demonstrate a child's achievement by two sub-levels every year.  |
| Interpretations of vocabulary used/articulated in a professional context e.g. Enjoyment | Develop awareness of the difference between: Taking pleasure from experiences in mathematics lessons (a social norm) or taking pleasure from mathematical experiences(a socio-mathematical norm)  |
| Use of resources  | Knowledge and understanding of why a resource is being used. Is it to scaffold the learning of a concept, e.g. the use of familiar objects to quarter visually and practically, or is it to excite children in mathematics, where the resource is bright, colourful and fun. Developing this understanding could potentially improve not only the use of good resources, but also appropriate resources by all teachers in mathematics. |
| Professional Independence   | CPD for experienced teachers to understand how the relationship between autonomous teachers and autonomous learners.  |
| A Teacher's Voice   | CPD for teachers to reflect, analyse and discuss ways of working within their institution against research finding, but within the current political climate of professional disempowerment.  |

Table 10.5: Possible applications of research findings

The table above provides possible applications of the research findings presented in this chapter. The final chapter that follows will present limitations of the work here, possible future directions and personal reflections of the PhD research process.

## Chapter 11 Conclusions

This chapter is presented in three sections where I:

- revisit my initial research questions and summarise the two phases of the study.
- consider the limitations of my work.
- offer a personal reflection on the whole PhD journey.

### 11.1 Concluding remarks

The initial stimuli for this research were my experiences as a teaching assistant, a parent of primary aged children, a primary mathematics coordinator and, latterly, a teacher educator of primary teachers. All had left me struggling to understand how the different ways teachers worked in the whole class phases of their lessons impacted on children's understanding of and competence with mathematics. Additionally, I had also worked as a member of an EU-funded comparative project and had observed teachers from different cultures exploiting, both successfully and unsuccessfully, a variety of approaches hitherto unfamiliar. Consequently, the main aim of the current study was to undertake an in-depth investigation of teachers' beliefs about and actions in the whole class direct teaching phases of primary mathematics lessons in order to understand more fully the interplay of belief and practice in this important aspect of a lesson.

The aim was addressed through the following research questions (as presented in Chapter 2.4)

The main research question:

*How do primary teachers conceptualise the whole class interactive phases of their mathematics lessons?*

Sub Questions:

1. *What knowledge and beliefs underpin those actions?*
2. *In what ways do the espoused beliefs resonate with the enacted?*
3. *What justifications do they present for their actions?*

To answer these questions I undertook multiple case studies (six teachers) in two phases. I examined how each of them presented mathematics to their children and their rationales in support of their approaches in WCIT. Due to the nature of the research questions three approaches to data collection were employed. Firstly, a preliminary interview, focused on their life histories as both learners and teachers of mathematics, was undertaken to ascertain

- Teachers' beliefs about and attitudes towards mathematics ,

- their beliefs about the teaching of mathematics and finally
- Their espoused beliefs about what they do in the classroom to engage children with mathematics.

These interviews were followed by a series of video-recorded lesson observations, with, between two and six lessons observed for each teacher, undertaken to ascertain:

- The Mathematical Intention (MI) emphasised during the whole class interactive (WCI) phases of the lesson
- The pedagogical approaches (PA) emphasised in WCI phases
- The Classroom Norms (CN) emphasised in WCI phases

Each lesson was followed by a Stimulated Recall Interview to ascertain:

- The teachers' perspectives on the decision making processes underpinning their actions during WCI phases

The multiple case study was undertaken in two phases. In phase one (chapter 4), I collected and analysed data to ascertain the robustness of the research procedures and examine the appropriateness of analytical tools derived from the literature. In so doing I refined both data collection and analysis procedures in order to better address my research questions. In phase two (chapter 5), by means of these revised approaches, I investigated four primary teachers' beliefs and practice. These were critically analysed and discussed alongside related literature. Three key issues of theoretical interest emerged concerning the following:

1. Background influences
2. Pedagogical practices
3. Professional issues

The implications for future study were identified and discussed in chapter 10, where ideas were brought together to inform the mathematics educational research field of some new insights, some retelling of old insights - in a new way, and further information regarding reprofessionalisation of teachers to inform policy and practice.

### **11.1.1 Avenues for future research**

This thesis has described a small multiple, essentially qualitative, case study. As such, as with all PhDs, especially in the social sciences, it is limited in its scope and methods and, typically prompts more questions than it provides answers. These limitations have been discussed above, although I believe that they can be construed as prompting new avenues of inquiry. In the following I offer some suggestions as to what these may be.

Firstly, a view frequently found in the research literature is that case studies develop hypotheses for future testing (Flyvbjerg, 2006). My study has identified three core aspects of the belief/practice continuum; teachers' mathematical intents, pedagogical approaches and classroom norms. It would be entirely appropriate to develop survey instruments to investigate the extent to which the different perspectives presented by my case study teachers are, indeed, representative of the population of all primary teachers of mathematics. However, before such instruments can be developed, I think further research at the case study level needs undertaking, alongside further reviews of the literature, to ensure that any survey instruments are based on sound conceptual frameworks.

Secondly, it is not sufficient to understand the nature of beliefs or practice; we need to know more about how they interact. In this respect, further research will be necessary and, due to the complexity of the relationship, I argue that only through a critical mass of case studies are we likely to find relationships common to the teacher population as a whole. This is no small undertaking but important from the perspective of informing teacher professional development programmes.

Thirdly, it is not sufficient to understand the nature of beliefs, practice and their interrelations. My study has highlighted the significance of childhood experiences, typically familial, in the development of primary teachers' core beliefs about mathematics and its teaching. Although such findings were predicted in earlier studies (Askew et al. 1997), my study is the first to show the extent to which such experiences permeate teachers' professional identities. Consequently, I would argue that further research is necessary into the nature of such experiences and the ways in which they inform teachers' identities. Initially this would have to be through further case studies or, perhaps, interview surveys. Subsequent to such research one would be able to develop conventional survey instruments.

Fourthly, and the third point alludes to this, my study has indicated the importance of understanding the genesis of all three teacher characteristics. We know that teachers' formative experiences will necessarily differ but all of my project teachers experienced similar professional training and all work within the same curriculum frameworks. Consequently, despite the importance of familial experiences, I suggest we need to go beyond an analysis of such matters and investigate more deeply the genesis of teacher

beliefs about mathematics and its teaching. This, too, would probably be best undertaken as a case study designed to provide a critical mass of findings.

Fifthly, the evidence of my study is that the video-taping of teachers' lessons, followed by video stimulated recall interviews has the potential to transform teacher education programmes. It would be beneficial to undertake a systematic study, possibly a controlled experiment, of the impact of such practices on initial teacher education.

Sixthly, my study has indicated that teacher autonomy is an underdeveloped field. I think the research and teacher education communities would benefit from a systematic investigation of the nature of teacher autonomy and how it is manifested in primary classrooms in general and mathematics in particular.

Lastly, particularly relevant at a time of curriculum change, my study has shown that teachers interpret curriculum guidance differently. A study focused on how teachers make decisions in relation to such guidance would not only be very timely but also important in helping us understand more fully the nature of teacher professionalism.

## **11.2 The limitations of my work**

In the following I consider the limitations of my study. Firstly, despite the many advantages to be gleaned from a multiple case study, the first issue to stress is that one must approach notions of generality with caution, although, as Flyvbjerg (2006) notes, it would be wrong to assert that no generalisation is possible, as it "depends on the case one is speaking of and how it is chosen" (Flyvbjerg, 2006, p225). That being said, a qualitative case study methodology does not, of itself, allow the construction of generalised statements about the beliefs, attitudes and practices of primary teachers in the English educational system. However, the findings and theorisation presented above, based on notions of literal similarity (Tripp, 1985), offer compelling perspectives on how teachers' beliefs and practices are informed by, for example, their early experiences as learners of mathematics in ways previously unconsidered in the literature. In other words, while my case study approach gave me the opportunity to examine the practices of six primary teachers' conceptual understandings in-depth and acknowledging that claims that these represent the conceptual understandings of all primary teachers are not possible, much has emerged of wider interest

to both the mathematics education and the mathematics policy making communities. Importantly, by way of further warranting the distinction between the two groups, the reader will recall that in chapter 9 that I offered several tables highlighting the similarities and differences between the two groups. These tables, yielding 47 codes, where each particular belief or behaviour was either present (1) or absent (0) from an individual teacher's profile, were subjected to a simple chi square analysis ( $\chi^2 = 145.9$ , df=46,  $p<0.005$ ). This indicated with some confidence that the distribution of the codes across teachers' profiles was unlikely to be random. In other words, despite this being a qualitative study, it behoves a researcher to exploit whatever tools are both appropriate and available. The chi-square test, undertaken on categorical data, confirms not the generalisability of the two groups but their robustness. That being said, if the characteristics of both the mediators and the mediated are as well-defined as they appear to be, then, drawing on Bassey's (1999) notion of fuzzy generalisation, it would not be inappropriate to suggest that both groups may have a resonance with other English primary teachers.

The selection of the individual teacher participants as leaders and ambassadors of mathematics drawn from a particular geographical location could be seen as another limitation. Due to the constraints of combining part time study with full time employment, there was little opportunity to work with teachers from other parts of the country, which may have provided a wider range of prior childhood and professional training experiences. Nevertheless, it is not clear, particularly from the perspective of case study, whether a wider trawl of teachers would have had any substantial influence on what I had been able to research.

I also acknowledge that a longitudinal design would have gathered richer data. Following a group of teachers from their initial teaching experiences and then revisiting them at, say, three yearly intervals, would have allowed deeper and, possibly, more informative insights to emerge with regard to how teachers conceptualise and implement the WCI phases of their lessons. It would also have enabled me to examine the extent to which practices change over time and how constraints, such as a school's managerial team or government initiatives influence practice and the warrants teachers offer.

Another limitation of my project derives from the fact that I collected, analysed and interpreted my data from my 'point of view' as a former mathematics specialist teacher and

now a primary teacher trainer specialising in mathematics education. Ideally, there would have been a team of researchers who, collectively, would have provided alternative interpretations of the data set. Again, from the pragmatic realities of a PhD project (i.e. funding), the analysis and interpretation of those data could only be carried out by me, from my perspective as an ‘insider’ primary teacher/trainer. Yet I should also acknowledge that the knowledge and experience I have has offered a better understanding of teachers’ interpretations of influences placed upon them in the classroom today.

Finally, most beliefs-related research, however, has approached the problem through interviews, questionnaire-based surveys or classroom observations. Each of these has been shown to provide important but, typically, isolated insights into the relationship between espoused and enacted beliefs. My project, based on interviews (initial and SRI) and classroom observations, may have its limitations but it has been able to provide insights other studies would have failed to find.

In chapter seven I examined the implications of this study and suggested further avenues for future research. In so doing, I identified questions for further research. However, I believe that a PhD, especially in the social sciences, is by its nature meant to create more questions than answers. Therefore the limitations of my work could be seen as avenues for future research.

### 11.3 Personal reflections

The journey towards a PhD is, or should be, a reflective process. Having achieved my goal, I realise how this journey has changed me in a variety of ways. In regard to myself as a researcher, I have become aware that every research design presents both strengths and limitations. Researchers need to consider both and, from a pragmatic point of view, decide which methodology and methods is most appropriate for addressing their research questions. Just as I found when I analysed the data derived in the phase one of my project, which may only become clear after the research has begun. Continuous reflection is therefore essential.

Furthermore, a researcher needs not only to be well-organised and prepared for entering the field for data collection but also aware of the unpredictable obstacles that may appear, as my early personal experience has taught me. Consequently, my experiences have led me to conclude that one has to maintain a *laissez-faire* attitude and accept that when working

part-time (or spare-time), one has to be patient, flexible and persistent in dealing with the difficulties that arise and adapt one's research design to changing circumstances. A PhD is more than just the thesis; it is a process through which one acquires a set of key transferable skills which will continue to evolve, develop and refine as further research is undertaken.

Throughout the last six years I have acquired many of those transferable skills. I have also learnt how isolating it can be for a PhD student who is, essentially, the sole owner of, for example, the deep knowledge of the literature of his or her field of study. I have learnt to accept, even after a year on an approach to data analysis, there are times when one has to accept the inevitable and just dump what has been done. This was the hardest challenge of my journey; to work on something just to find that it did not address, in adequate ways, my research questions. Although a fresh conceptual approach was required, the study, and more importantly, my knowledge and understanding of qualitative research is the better for it.

As far as myself as a teacher trainer is concerned, my PhD work, its processes and outcomes have changed me beyond recognition. I believed that primary teachers who were enthusiastic and committed to developing children's knowledge and understanding must be similar in many ways, and that they all shared an understanding of the enjoyment of learning mathematics. Askew et al. (1997) informed us that there were three types of primary teachers of mathematics and the most successful were the *connectionists*. My study extends these ideas. I found two groups of teachers within a set of enthusiastic mathematics specialists. The mediators displayed a professional independence, the other did not. While the evidence of this study indicates two well defined groups of teachers further research will be necessary if we are to test the veracity of the two groups for all teachers.

As a trainer of primary teachers, although my work after my PhD will disseminate many of the ideas through journal articles and seminars, I would like to develop an appropriate programme for the mathematics specialists with whom I work. I would also like to explore with generalist primary trainee teachers their awareness of what their core beliefs are about learning and how they might impact on their teaching in the future.

As an academic working in teacher education I believe I am in a privileged position within the community within which I work. Teacher educators have partnerships established with local schools, and with the recent demise of local authorities, the time is right for research

informed expertise to play a part in the future generations of practising teachers. Finland, educationally the most successful European nation, has had a compulsory research-based approach to teacher education for more than thirty years (Antikainen 2006; Laukkanen 2008; Jyrhämä et al 2008; Niemi 2012; Niemi & Jakku-Sihvonen, 2006; Sahlberg, 2007; Savolainen 2009; Tuovinen 2008), and I feel it is time to promote something similar in England. Consequently, I aim to create and establish a continuous mathematical learning culture through both the mathematics pathway masters' course and CPD courses that I am currently developing.

As a new researcher I am very excited at the prospect of continuing to engage with both practising and trainee teachers in the furtherance of better mathematics teaching in England. My research has shown me, through the use of SRIs, how important it is for teachers to have time to discuss their concerns and ideas. The Williams' Report (2008) recommended that teachers be offered appropriate CPD opportunities, and my experience on this study has overwhelmingly confirmed this idea. There are also gaps in the research between early years' research and mathematics education, leaving little for early years and primary practice to draw from. I would like to explore this area of research further, in particular a child's developmental stage between the ages of five and eight years old.

I have greatly enjoyed working in the qualitative research domain, and hope to further develop my knowledge and understanding of this. From an epistemological point of view I have appreciated having the experience as an actor/primary teacher before experiencing the point of view as an observer of phenomenon. The shift was not straightforward, but the outcome was enlightening. I can now appreciate greatly the importance of being able to step out of a familiar process, for example the teaching mathematics to primary children, and become the *outsider* looking in, not to evaluate what might be going on, but to try to understand what it is that is going on (Robson, 2002).

*Once we accept our limits, we go beyond them (Albert Einstein)*

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# Appendices

## **Appendix 3.1**

### **National Numeracy Framework for the teaching of Primary Mathematics Extract**

**(DfEE 1999, pp.13-16)**

#### **Oral work and mental calculation**

The first 5 to 10 minutes of a lesson can be used in a variety of ways to rehearse and sharpen skills, sometimes focusing on the skills that will be needed in the main part of the lesson. On different days you might choose to do one or more of these:

- counting in steps of different sizes, including chanting as a whole class and
- counting round the class;
- practising mental calculations and the rapid recall of number facts in varied ways(for example, by playing an interactive number game, by giving examples of ‘a number one less than a multiple of 5’ or ‘a calculation with the answer 12’);
- figuring out new facts from known facts and explaining the strategies used;
- building on a previous strategy, and then developing it;
- identifying facts which children can learn by heart and discussing ways of remembering them;
- reviewing an activity done at home.

In this first part of the lesson you need to:

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- get off to a clear start and maintain a brisk pace;
- provide a variety of short oral and mental activities throughout each week;
- prepare a good range of open and closed questions to ask the class;
- ensure that all children can see you easily and can and do take part;
- target individuals, pairs or small groups with particular questions;
- use pupils’ responses to make an informal assessment of their progress;
- brief any support staff to position themselves and give discreet help to any children who need particular support;
- avoid disruption from too much movement of pupils about the room;
- avoid running over time and move smoothly to the next part of the lesson.

## The main teaching input and pupil activities

The main part of the lesson provides time for:

- introducing a new topic, consolidating previous work or extending it;
- developing vocabulary, using correct notation and terms and learning new ones;
- using and applying concepts and skills.

In this part of the lesson you need to:

- make clear to the class what they will learn;
- make links to previous lessons, or to work in other subjects;
- tell pupils what work they will do, how long it should take, what, if anything, they need to prepare for the plenary session and how they are to present it;
- maintain pace and give pupils a deadline for completing their work.

When you are working directly with the **whole class** you need to:

- demonstrate and explain using a board, flip chart, computer or OHP;
- involve pupils interactively through carefully planned questioning;
- ensure that pupils with particular learning needs in mathematics are supported effectively with appropriate resources and wall displays, and adult help;
- identify and correct any misunderstandings or forgotten ideas, using mistakes as positive teaching points;
- highlight the meaning of any new vocabulary, notation or terms, and get pupils to repeat these and use them in their discussions and written work;
- ask pupils to offer their methods and solutions to the whole class for discussion.

When you are working directly with **groups** you need to:

- have a manageable number of groups (usually a maximum of four), so that you know what each group should be doing at any time;
- decide how groups will be introduced to tasks and how the group work will end;
- control the degree of differentiation (for example, provide tasks on the same theme and usually at no more than three levels of difficulty);
- provide activities, tasks and resources that don't involve children in a long wait for turns and which keep them all interested, motivated and on-task;
- sit and work intensively with one or two of the groups, not flit between them all;
- brief any support staff or adult helpers about their role, making sure that they have plenty to do with the pupils they are assisting and will not interrupt you;
- avoid interruption by pupils by making sure that those working independently in a group know where to find further resources, what to do before asking you for help and what to do if they finish early.

When you are providing work for **individuals or pairs** you need to:

- keep the class working on related activities, exercises or problems;

- u target individuals or pairs for particular questioning and support;
- u during paired work, encourage discussion and co-operation between pupils.

### The plenary session

The plenary is an important part of the lesson. It is a time when you can help pupils to assess their developing knowledge and skills against any targets they have been set and to see for themselves the progress they are making. It is also a time when you can relate mathematics to their work in other subjects: for example, how their work on calculation will be used in science, or how their measuring skills will be practised in physical education.

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For example, this part of the lesson can be used to:

- ask pupils to present and explain their work, or mark a written exercise done individually during the lesson, so that you can question pupils about it, assess it informally and rectify any misconceptions or errors;
- discuss and compare the efficiency of pupils' different methods of calculation; help pupils to generalise a rule from examples generated by different groups, pairs or individuals;
- draw together what has been learned, reflect on what was important about the lesson, summarise key facts, ideas and vocabulary, and what needs to be remembered;
- discuss the problems that can be solved using the ideas and skills that have been learned;
- make links to other work and discuss briefly what the class will go on to do next;
- remind pupils about their personal targets and highlight the progress made;
- provide tasks for pupils to do at home to extend or consolidate their class work.

In this part of the lesson you need to:

- have a clear idea of the purpose of the plenary session and what you want to achieve in it;
- make sure that the main part of the lesson does not over-run, so that there is enough time for the plenary;
- plan carefully how pupils are to present their work, if they are to do this, and how long it will take;
- bring the lesson to a close and evaluate its success.

The outline structure of a typical lesson should not be seen as a mechanistic recipe to be followed. You should use your professional judgement to determine the activities, timing and organisation of each part of the lesson to suit its objectives.

In the main part of the lesson, in particular, there is scope for considerable variety and creativity, with a different mix of work with the whole class, groups, pairs and individuals on different days, although each lesson should include direct teaching and interaction with the pupils, and activities or exercises that pupils do. Overall, there should be a high proportion of work with the whole class but there may be more in some lessons than in others. For example, at the start of a new unit of work you might need more time for explanation and discussion with everyone together for the whole lesson, and the plenary may be very short. On the other hand, where you have identified general errors or misunderstanding during the main part of a lesson, you might need a longer plenary to sort them out. At the end of a unit of work it can be useful to use the plenary to look back with the whole class over a number of lessons to draw together what has been learned and to identify the key points and methods that you want pupils to remember and use in the future. For this kind of plenary session, you may need a much longer time than usual.

## Appendix 3.2

## Semi-structured interview schedule (phase one)

Name \_\_\_\_\_

## School

Date

|    |   |
|----|---|
| 1  | What attracted you to primary teaching as a career?   |
| 2  | Why did you specialise in mathematics?  |
| 3  | What was your experience of mathematics at school?<br>What was the teaching like?                                   |
| 4  | What emotional impact did the learning of mathematics at school have on you as a learner?                           |
| 5  | What do you enjoy about teaching mathematics?   |
| 6  | What have been the major influences on your beliefs about mathematics and mathematics teaching?                     |
| 7  | As a teacher, what aspects of the subject do you feel it is most important for your pupils to experience?           |
| 8  | If I were to video-tape a typical lesson of yours, what would I see?  |
| 9  | If I were to ask your children in your class the same question, what would they say I see?                          |
| 10 | Describe your ideal classroom environment for the teaching of mathematics   |
| 11 | What do you think are the strengths and weaknesses of the National Curriculum? Why?                                 |
| 12 | What do you think are the strengths and weaknesses of the NNS/PNS?<br>Why?  |
| 13 | What do you think other teachers think are the strengths and weaknesses of the National Curriculum for mathematics? |
| 14 | What do you think other teachers think are the strengths and weaknesses of the NNS?                                 |
| 15 | What do you think about the 3-part lesson?  |
| 16 | For you, what are the key elements of the oral mental starter?<br>+ve/-ve   |
| 17 | For you, what are the key elements of the main part of the lesson?<br>+ve/-ve                                       |
| 18 | For you, what are the key elements of the plenary? +ve/-ve  |

|    |   |
|----|---|
| 19 | What are the strengths and weaknesses of the whole-class teaching phase?  |
| 20 | What are the strengths and weaknesses of children working independently?  |
|    | <i>Possible extra questions</i>   |
| 19 | Describe the sort of topic which you feel you would wish to teach. What is it about the topic that makes you feel that way?     |
| 20 | Describe the sort of topic which you feel you would not wish to teach. What is it about the topic that makes you feel that way? |
| 21 | Do you feel that primary teachers have moved on from the content of the NNS? Why?   |
| 22 | What are your opinions of reports suggesting that mathematics teaching in this country is failing our children?                 |
| 23 | Is there anything you would like to add?  |

|  |                           |
|--|---------------------------|
|  | Personal experience       |
|  | Personal views            |
|  | Personal preferences      |
|  | Personal reaction/opinion |

|   | <b>Theme</b>                  | <b>Description</b>   |
|---|-------------------------------|--|
| 1 | Personal Experience subject   | -Attitudes and beliefs of the teacher about the subject of mathematics   |
| 2 | Personal Views - teaching     | Teachers' personal views on the teaching of mathematics  |
| 3 | Personal Preferences teaching | Teachers' preferences in the classroom dynamics and didactic strategies when presenting mathematics  |
| 4 | Personal Reaction curriculum  | Teachers' feelings about past and current Government expectations and recommendations e.g. introduction of and implementation of the NNS and PNS |

## Appendix 3.3

### Initial Interview transcript (example of Caz)

[00:00:21.06] What attracted you to primary teaching?

[00:00:23.27] Em, I think the range of subjects, so you are not just focusing on one subject, you get to do a little bit of everything.

[00:00:30.27] Em, I think the age of the children as well, in terms of, em, if you, sort of, think of children as blank slates, the younger they are the blanker they are and...

[00:00:39.29] Em, just their enthusiasm, em, although you get behavioural issues, and home issues and things like that

[00:00:46.26] Em, because the children are young, you don't tend to get so many learning barriers from that. You don't get so many attendance issues and things like that. So you're able to work more with the children and actually teach.. Em,..

[00:01:02.11] That's great. That's great, that's fine.

[00:01:08.00] Right. Em, did you do a specialist in your course?

[00:01:13.13] Yes, I did. Em, my specialism was advanced early years.

[00:01:17.24] Aaah!

[00:01:17.29] Em... and, em, part of the reason for that was because of location of course and things like that.

[00:01:25.21] So where did you study?

[00:01:26.13] Em, I studied, I did a SCITT course, which was based in Bedford.

[00:01:30.07] Oh Yeah.

[00:01:30.10] Em, and then I did one of..., this is, just finished my seventh year teaching and one of the years I did teach there, sorry. Em, and going, em, and teaching reception isn't something I wouldn't consider again, I would, possibly, do that again.

[00:01:49.22] So why did you choose the early years? Was it the, sort of (unintelligible), cos we talked about your, primary, you know, why primary but, obviously the early years, you said your choice was to do with location et cetera. But was it something that you, you really wanted to, to work with early years...

[00:02:04.08] Yeah... I think, em, my degree was psychology, so I came from a child development background,

[00:02:09.23] Yeah, yeah...

[00:02:10.09] And it was more that side of it the,... with , sort of, the foundation stage curriculum. You do get more in terms of child development and the personal, social, emotional development.

[00:02:20.27] And looking at the whole child and things like that. So... And the stuff that I learned when studying psychology but also when I was doing the advanced early years bits, is applicable to the older children, absolutely, so

[00:02:31.16] So you felt it was a good foundation, good grounding,

[00:02:34.05] Yes...

[00:02:35.23] For whatever you teach, really...

[00:02:35.26] Brilliant. So, em, mathematics, then. You, you're the coordinator of maths here, what got you interested or, have you always liked math...?

[00:02:44.05] Always, always enjoyed maths. Always had, em, it was the thing I was good at school. So naturally, that was my natural talent at school.

[00:02:53.20] Em, with mental maths, em, I then studied it at GCSE and A level. Em, during my psychology degree I did take a maths module, which was really hard (laughter), but I did enjoy it.

[00:03:02.12] Statistics?

[00:03:05.17] No, em, ....

[00:03:08.01] It usually is, there's a lot of statistics in psychology...

[00:03:10.11] I remember doing matrices and matrix... yeah. Em, and, em, so I've always enjoyed it and just, I think, when I first started teaching I found it difficult to teach because it was so obvious to me.

[00:03:22.06] I couldn't understand why it wasn't so obvious to everybody. Em, so I've spent a lot of time thinking about how I teach maths.

[00:03:29.27] Em, and really I find it quite easy to teach those children who were like I was when I was at school, who love it and enjoy it and want to do it.

[00:03:36.14] Em, and I struggled a bit more with the children who have the learning barrier with maths and the maths phobia, I call it.

[00:03:44.18] Which, I think sometimes, it quite often comes from parents but also, if you're not mathematical inclined, then it just doesn't make sense to you. It's almost as if somebody is speaking a foreign language.

[00:03:53.22] Em. In particular, any particular topic? Do you find that....

[00:03:58.11] Em, I think the stuff that, I don't think it's necessarily the topic but perhaps the stuff that as teachers, the topics we choose or don't teach so practically. Em, so, you've got your shape, space and measure, which we always get the jugs out we always get the metre rulers out and, so the children are doing and they don't, perhaps, realise it's maths and,

[00:04:19.15] Or if you give them a context with maths and so they've got a reason for doing something. And again, em, we've done something recently, we had a pirate week, so, they weren't doing maths they were on a treasure hunt. And so then they didn't see it as maths.

[00:04:34.01] Em, so, I think perhaps when you're teaching, perhaps more the calculation and the number stuff and you're not doing it so practically, or not giving it that context that's when children are sat down with their pencil and paper, and they haven't had that practical input before, that's when they struggle.

[00:04:47.07] Em, OK, going back to your own school experience of mathematics, you said it, oh, you found it really easy and, er, it was, you called it, what was it, your natural talent, em, was that just something that, when did you sort of become aware of that? Was it, do you remember much, for example, about primary or, em, did you become more aware in secondary? Em, were there any particular teachers that inspired you or helped, helped you to, sort of, see things or ....

[00:05:17.14] Em, I think during, sort of, it was something I always would do at home with, em, dad and my brother's only eighteen months younger than me so we were, we did lots of stuff together and he enjoyed it as well so we did stuff together.

[00:05:28.24] Em, and during lower school I think I just enjoyed the whole of lower school and just probably assumed everybody else would, probably assumed everybody else was having the same experience as me.

[00:05:39.20] And then, perhaps, going on to middle school, when you're set into groups and things. And then perhaps became a bit more competitive in maths.

[00:05:46.29] Em, I probably had loads of good teachers. I couldn't, sort of, pick out or single to one. We had lots and lots of good teachers, em... Yeah, and it's just something that I've always enjoyed.

[00:05:58.21] I suppose there was one particular teacher in middle school who, I can't remember her name, that's terrible, Miss Gardner I think, I'm not sure. Em, and she was obviously had a love for maths as well. Em but I wouldn't say my love for maths came from her because I'd already got it. But she probably, I probably had a really good two years with her as well.

[00:06:20.26] Hmm. So, really, you'd sort of sum up the teaching you experienced as really good.

[00:06:25.23] Yes, absolutely.

[00:06:27.20] Er, cos you don't remember any bad ...

[00:06:28.19] No.!

[00:06:28.23] That's really interesting. There's not many people that can say that, that's really great. Right, em, so obviously Dad had an influence as well with it, em, cos you say you, you felt that you, er, well, you do as a child, you just think everybody has the same experience as you at home. Em, but Dad, is he particularly interested in mathematics or the sciences or is he just interested in knowing what you were doing or

[00:06:55.07] Yeah, he was just interested in everything, really. He was one of those people, em, it wasn't just maths he'd do with us, we'd do, he'd do cross words and puzzles and things. Just, sort of, I suppose, em, cryptic stuff, I suppose if you think about the sort of Nintendo DS as you get now with your puzzles and games, we used to do all that but with

pencil and paper together, rather than, em, but, em, not particularly maths but sort of logic puzzles.

[00:07:18.26] Hmm, that's really great. Shame more children don't do that...

[00:07:24.06] Yeah..

[00:07:25.12] Er, great, so, em, so nothing else. What about, em, during other subjects, when you were learning about people like from history, were there any one, sort of, you thought, wow, em, I mean, I'm thinking of when I went to my, em, when I did my degree course, I came across Escher and looked at Escher's work and, cos I've always loved art and patterns and things and, is there, is there any one for you that's in that, sort of, perhaps in the arts or, or mathematician or scientist that you could say, oh yes, I really admire those sorts of, those people that look at these things differently to the way I looked at them...

[00:08:06.23] Em, I suppose the only person that would stand out would be Fibonacci.

[00:08:11.18] Yeah?

[00:08:11.24] Yeah. Em, and I do use him in some of my teaching

[00:08:15.15] Do you? Can you say a little bit about that?

[00:08:17.07] Em, from what I know about him, em, this might be inaccurate, em, he either discovered or was the first person to write about the, the use of the number zero. And so, em, if you, sort of, explain that to year four children and just try and have a day or a couple of days of maths without zero, and they realise how important that digit is and they, I mean, I can't comprehend what maths must have been like without zero.

[00:08:45.27] And we use it all the time in year four. You know, it's a placeholder, and its, you know, multiplying by ten, dividing, and all the decimal stuff. And so, and then we, perhaps, go, get a bit, em, side-tracked and go and look at the old money system as well. Because that's not base ten. Em, so we look at things like that.

[00:09:01.27] We're also looking, em, in nature for Fibonacci numbers and things. There's lots of different investigations you can do that will come up with the Fibonacci sequence. Em, so you can always give each group a different investigation ...

[00:09:14.12] Em, so do you plan that in?

[00:09:15.19] Yes, yes, yeah, it's planned in. Em, I'm just trying to think of one particular one. We do one where we have, they have, em, detached houses and semi-detached houses. And they have to see how many combinations they can get of having one house in the street, then two houses, then three houses, then four houses, and the number of combinations is the Fibonacci sequence.

[00:09:34.13] So they'll all do a different investigation and they'll be just amazed that they've all come up with the same... It's just a, ..., a play on words, really, what they're doing. They don't know that they're doing the same thing.

[00:09:44.06] Em, yeah, so, and then, you sort of, if you can do that with them at the beginning of the year, all through the years, you'll be with them in the middle of a lesson, oh, that's a Fibonacci number, and that's nice, that they've got that...

[00:09:55.01] Em, and then, say, some of the children that aren't so interested in maths but, perhaps, are interested in history, they'll get involved because they'll perhaps go and do some research on Fibonacci on the internet and find something out...

[00:10:05.24] And then, relate maths to that. So, yeah, that's...

[00:10:09.27] Yeah, year fours are lovely like that, aren't they?

[00:10:13.04] Yes, they are...

[00:10:13.22] They're so keen. Great, thank you very much. That's that was really interesting. Em, now, thinking about your maths teaching. You've already said that you look at Fibonacci, could you, sort of, sum up what you enjoy about teaching mathematics? What is it you like about teaching it?

[00:10:30.06] Em, I think it's.. there, there's a sort of magic of numbers, what they can do. Em, and when children realise that, and they become hooked on it, or perhaps when a child who isn't good at maths has been struggling with something and all of a sudden it will click for them.

[00:10:46.28] And I'll get that, em, I sort of enjoy the number stuff myself anyway, em, but, watching that with other children, I think, really, is the main thing.

[00:10:58.22] And that's what inspires you

[00:11:01.20] Yes, yes..

[00:11:01.23] Great. Thank you. Em, we've talked about, em, people that might have influenced you and you said, em, Fibonacci. Em, have there been any, sort of, events that you could say, in the world, or, em, in your own life, in your own experience that has also, perhaps, influenced you about your relationship with mathematics. Not necessarily the teaching, it could be the teaching, em, but, er, like you were saying with the, the logic, em, and thinking about Fibonacci and, em, houses.

[00:11:35.24] Obviously that's something, an activity, I don't know if you made that one up, but... you. you perhaps came across that ...

[00:11:41.04] Yes...

[00:11:42.00] Is there, is there anything you could say that you've, sort of, come across that you think, oh yeah that.. not necessarily, I don't mean changed your life (laughter) but was there anything that you thought, yeah, that was a turning point for me in a particular way?

[00:11:55.11] Em, I'm not sure about turning points. I do, I find, sort of, architecture amazing. And if you just look at buildings , I mean, I'm going to London at the weekend and just, it's just, whoever designed it and whoever conceptualised that those, that many hundred years ago and managed to put it into action...

[00:12:17.14] I mean, going back, sort of, to the pyramids and things like that, you've got that. But just, em, sort of, everyday architecture at, even at, where were we? The new St Pancras International Station and just, sort of, looking at the triangles and, it's really quite sad (laughter), looking at, sort of, the triangles and the, the sort of roof structure and how did they, how did, and how did they know what size, and just, it's just quite awe inspiring?

[00:12:42.07] So things like that, I'll quite often come back with and just em...

[00:12:45.18] And do you take that into the classroom? Are there times when you....

[00:12:50.02] Em, maybe (I can't tell what she says here), formal basis. Perhaps having a chat with a child who's, em, interested in maths and, you know, when we do on a Monday morning, what we did at the weekend, that might be something I'd share with them. Em, but probably not on a formal basis in terms of teaching.

[00:13:06.05] Great, thank you. Em, now thinking about yourself as a teacher. What aspect of mathematics do you feel is most important for the children, for your children to experience? Just in a maths lesson, is there a, something that you really want them to experience through their engagement with mathematics? Can you say anything... do you see what I mean?

[00:13:33.02] Em, ...

[00:13:35.01] Is there any experience that you want them to have. You know, cos, I don't want to put words into your mouth, em, so when you're thinking about your maths lesson, what do you hope that they'll all experience? Not necessarily one lesson but maybe a series of lessons or a unit of work or

[00:13:51.03] Em, I guess.... really to see maths as playful rather than hard work and laborious. Em, and to engage with maths in terms of the fun you can have with it. Em, perhaps, to them just want to go away and play with numbers. I remember I'd,.. I remember, sort of, spending hours with pen and paper and just doing all sorts. Not because somebody had said to me, do a page of ten sums or do this or do that, but just seeing what I could come up with.

[00:14:20.28] Em, and really to see numbers as fun, but also there's, sort of, infinite possibilities you can have with numbers and , em, I suppose I am more geared towards number than...

[00:14:35.26] Great, thank you.

[00:14:37.06] Is that what you meant?

[00:14:37.03] Yeah. Yeah, I mean, some people talk about, em, you know, the fun element. They want them to have fun. Em, but, em, but in different ways. You know, some people prefer to, sort of, think about fun in one way and then, another person, em, but also, em, you know, some people talk about confidence. Some people talk about, it just depends what's in your mind at the time.

[00:15:02.28] Em, you know, what will come out later, once I've seen you in your session and you did a particular thing in a particular way, you'll perhaps say, well, I wanted that child to, you know, develop their motivation or their confidence or whatever.

[00:15:15.22] So that comes out later. It, that, that's all. So it's just a kind of to, what's, sort of, in your mind as a, as a sort of a, overview, if you like. Em, that's all I wanted to get out this time. So, it's not meant to trip you up or anything.

[00:15:27.07] Em, OK, do you think there's a problem with mathematics for some teachers, to teach it. I mean, do you feel that there is, cos you talked about the maths, what did you call it, the

[00:15:38.29] The phobia.

[00:15:38.59] The phobia, em but do you feel that, em, not necessarily your colleagues here but maybe colleagues you've worked with before, do you feel that there's a.., or even some of the children, you've talked about phobia, perhaps you could talk about that a little bit.

[00:15:52.20] Yeah, em, I think in terms of teaching, em, sort of, (I can't tell what she's saying) problems, I would say would be, em, if teachers are, perhaps not sure of maths themselves and have that, sort of, lack of confidence, they would tend to be not so creative with their maths teaching. I think that applies to any subject, really. If you're not confident you're more likely to follow a scheme rigidly.

[00:16:14.22] Em, I think, sort of, the biggest problems I've come across is, unit, when I'm teaching in year four, a lot of the foundations I'm laying are for what they're going to do in year six, in year eight. And if I don't teach them properly in year four, that's got to be undone before they can learn what they need to learn in year six and year eight.

[00:16:30.28] Em, so, for example, we have a Bedfordshire calculation policy, em, which all the Bedfordshire schools (can't tell what she says), em, so that we're teaching all calculation based on number lines, rather than the door step method of addition and subtraction.

[00:16:49.09] Em, and so, if a teacher chooses not to do that, and in year three teaches them the door step method they get up to year four and then they can't, and the reason behind that is because it's more applicable for algebra later on. And then the children understand what they're doing with numbers, what they're writing down, represents what they see in their head. And how they, em, mentalise the maths space.

[00:17:11.08] Rather than a trick of numbers that you can do, which when you get to a different number or you get to decimals, you might not know how to apply that trick. Em, and things like, em, perhaps in year two, if they're taught to multiply by ten as adding a zero, then when we get on to decimals in year four we have to undo that and talk about moving the digits across and using placeholders.

[00:17:31.13] So, I think if you're not confident with maths as a teacher, and you can't see the progression and where the children are going to, you know, because we have the lower school system in Bedford, a lot of teachers, they only teach up to year four, so they, perhaps, don't know the year five and six curriculum. Em, so those sorts of things

[00:17:50.29] And what about children? What do you find the problems are when children come up to you, and obviously you mentioned some of the things that, perhaps, misconceptions that they have, and children will always have misconceptions whether you've taught well or not, but, em, are there particular problems that you feel are quite, em, pertinent or, things that you come across, and you think, yeah, I've got to really work on this. I mean, sometimes it's, doesn't, doesn't present itself one year but the next two years it does...

[00:18:20.12] Yeah, I think that's quite, em, true. You will get a class of children and, em, for some reason your last class picked this up really quickly and they, em, they. We, I think I started with the year four class I just had, when we started looking at decimal places at the

beginning of the year, em, even the children who, er, are naturally mathematically inclined struggled with what I thought would be easy.

[00:18:44.04] Em, and so I decided to put it in, sort of planned for it, sorry, (coughs), Em, planned for it so it was little and often. Em, and then all of a sudden it just clicked into place for them and it still, sort of, bemuses me. I still don't know why or how (laughter).

[00:19:00.22] There's no rhyme or reason sometimes.

[00:19:03.01] No. And I think that when you get, em, a whole class block with something, that's what I do. I do it little and often. Em, and then once a couple of the children have got it, I use them to explain it to the rest of the class. Em, because hearing it from a peer in your, sort of, own language is quite often... It either reinforces it or it might just make sense in a way that I can't explain to them.

[00:19:27.27] Thank you very much, that's great. So, when I come in and videotape a maths lesson, what would I see?

[00:19:35.02] Em, I would hope that you would see a really sort of quick, em, pacey ornamental starter, which was interactive and involved as many of the children as possible, and was fun. Em, in the hopes that they would forget that they were doing maths and just join in.

[00:20:03.04] Em, so they'd see it as a game. Em, then in terms of the maths lesson, we look at what we were learning, em, we may be following on from the day before or it may be a while since we'd done the topic so we'd look at what the children already know.

[00:20:22.20] Em, I don't get as side-tracked as I used to, cos I tend, cos I enjoy maths if we go off on a tangent, I tend to follow it. I must try not to do that. Em, hopefully the, sort of, main structure of the lesson, there's, I tend to do practical stuff before paper stuff. So if we're doing, say, addition em, you might, there might be, sort of, three really practical lessons and then one or two paper lessons to follow.

[00:20:45.20] So, if it was a practical lesson it'd be the children engaged, em, using all sorts of equipment. We might be outside, there might be ICT going on. If it was a paper lesson, hopefully because of the practical experiences they'd had, they'd feel confident to tackle that and they'd be all joining in.

[00:21:06.03] Em, I don't ask the children to put their hands up. We use a lot of talking partners. So every question I ask I give the children a chance to share their answer with their talking partner. That's, em, that's a whole school thing we do here. We started with literacy but it's a huge thing for confidence so that if you don't know the answer, you can give the answer your partner gave. So you can join in.

[00:21:33.16] If you do know the answer but you don't want to say it in case it's wrong, then you have the opportunity to say it to your partner. So, your partner can tell you what they think and you don't feel then, so, under pressure when your answer. And all those sorts of things.

[00:21:44.12] Em, ...

[00:21:46.19] How long have you been doing that?

[00:21:47.23] Em, two or three years now...

[00:21:49.21] And do you find that it's, you know, successful..

[00:21:51.24] Really successful, yeah.

[00:21:53.27] Can you say why?

[00:21:55.13] Em, I think because all the children prepare an answer. If you've got hands up, as soon as, you know, the, sort of, top child puts their hand up, Ohh, everybody else may panic. They may go, Oh, he's got the answer, I haven't. And then that stops your brain from working and thinking.

[00:22:12.10] Em, they all know that they may be chosen to offer an answer, because as soon as they put their hands up its hands down and I'll choose somebody to answer. Em, whilst they're doing their talking partner thing, I'm not sitting there doing nothing, I'm, sort of, tuning into each conversation.

[00:22:27.14] I might have a child or a couple of children that I've chosen to focus on for a particular topic, and I'm, sort of, assessing that as we're going along, so you've got some assessment in there. Em, I think it is the confidence thing.

[00:22:41.18] Brilliant, that's great. Thank you very much. Em, and so you say you do practical quite often. So you have lots of resources, em, could you just, sort of, talk to me about the sorts of resources, the norm for the resources, what sort of resources might you have?

[00:22:55.27] Em, we'd use we've got all sorts of 2-D shapes, 3-D shapes, em, place value cards, digit cards, em, number lines. We've actually got physical number lines that the children use for the whiteboard. Quite often we do work on the whiteboards with pens so that the children don't feel like they're committing themselves too much when they're initially learning about something.

[00:23:19.23] What do you do with those? Do you photocopy them afterwards or something?

[00:23:22.15] Yes, yeah.

[00:23:24.28] Great. Em, so, cos you started talking about your, you almost have a routine, that you have a quick, sort of, er, ornamental starter as it were.

[00:23:32.23] Yeah

[00:23:33.17] Em, sort of quick, pacey, game-like and then you have your main. Em, I mean, do you have a, do you purposefully have a plenary at the end with the old, you know, three part lesson or do you, kind of, it's, it's fluid and it's flexible and

[00:23:50.10] It is fluid and flexible. And it would depend upon the lesson. Em, there may be lessons where we do, we stop ten minutes before the end and we come together. Em, we do a lot of AfL here, so, em, sometimes with a plenary I've got, sort of, nine questions... laminated AfL questions and I'll just give each partner a laminated question and tell them... and so it would be, what was difficult about this today? And they'd both answer that question to their partner and then we'd swap the questions round, so they're doing lots of AfL among themselves.

[00:24:20.24] And again, I'll be tuning into that. Sometimes, because of the AfL, because of the way that we are reviewing all the time that we're going along, the plenary might not happen at the end. We may stop in the middle of the lesson, if somebody's got a problem, em, quite often within maths what I find is you'll do the whole class teaching, and although you may try to model on the board any mistakes that you expect the children to make, there may misconceptions that arise as well. They're doing their group work so you may stop the class then.

[00:24:48.19] We've got really good ICT here, so we've got (pointing) the image grabber. Which means I can just put a piece of work under there and it's on the whiteboard. So we can look straight at that. Em...

[00:24:56.24] So that's, that's something that you, you use as a resource really, isn't it

[00:25:00.12] Yes, yes, absolutely

[00:25:03.01] So, and so the children feel, so that's something you use with children's work themselves, that product there and, em, you use that, so, and that's normal. That's all the children expect it, they don't feel, (unintelligible) they always feel that. That's great, thank you very much.

[00:25:20.20] OK, so, em, what do you think the children might say to me if came in and said, OK, what's Ms Smith's maths lesson like (laughter) what do you think they would say to me?

[00:25:31.09] Em, it would certainly depend on who you ask (laughter). Em, I think the more able children would be very enthusiastic and say they enjoy it. I think the less able children would probably say it's hard..

[00:25:52.02] So do you group them then? Are they always grouped?

[00:25:53.20] Not always. I do have set maths groups which are very flexible in terms of, em, I don't, sort of, set them every half term as a child may move after three days, if they're not in the right group. Em, but we don't always work according to ability. There may be times when I want them to purposely work mixed ability. If we're doing something cross curricular they may be grouped according to the other subject that's involved.

[00:26:16.19] Em, so I would look at what we were learning and the activity I wanted them to do and personalise it in a number of different ways, really. It might be by resource, it might be... it wouldn't always be by ability although that...

[00:26:33.12] Thank you very much. Em, so would you say, on the whole, that they enjoyed their mathematics lessons? When they come to you or when they leave you or, what would you say they would say?

[00:26:45.13] Em, yeah, I think so. I try to, I'm trying to think of, there was one little girl last year who, sort of, for the first two weeks cried every maths lesson. Em, and then by the end of the year, she still, you know, she'll never love maths, she'll never, but she was, if we were learning something and she was struggling with it, she'd come and ask for extra homework for it.

[00:27:08.05] Which I felt was, she probably wouldn't enjoy doing that homework as much as she'd enjoy doing art or literacy, because that was, but she realised, but she wanted to be good at maths and she realised that she needed extra practice at it.

[00:27:21.00] So she was more motivated when she left you class...

[00:27:23.08] Absolutely, yes, and we do, sorry...

[00:27:24.29] No, no, go on...

[00:27:25.10] We do lots of talking about multiple intelligences and that different people are good at different things. So, hopefully the children that do have that block with maths, would feel like, OK, well this is my block but everybody else has got a different block and I've got a different talent and just realise that it's something that they need to work a little bit harder at, and be open to that.

[00:27:43.21] So that's, is that something that's whole school or is that, kind of, your, sort of....

[00:27:47.27] Em, it's supposedly whole school but it's one of the, you know, we do so many things it's one of the things that hasn't taken off so well.

[00:27:53.25] Em, but it's something I've been really interested in, so....

[00:27:58.19] With your psychology background... and early childhood, really, isn't it?

[00:28:04.21] Great, thank you. So, em, when I go out into schools and see our students we, em, we do have em, a wide range of planning towards maths teaching. And some, some schools have taken on, well they call it, em, connected curriculum, theme-based curriculum, critical pathways and goodness knows what else. But, em, they talk about, some talk about having maths actually within it, but some outside it. Em, is there a, sort of, where is your school at the moment in that, that, sort of situation?

[00:28:55.22] Em, quite transitional really. We've just finished, this year, and we've map..., everything's been discrete. Em, we've perhaps blocked things, so we'd have two weeks of science in the afternoons and two weeks of geography. Em, but what we have done this year is quite a few whole school weeks where we've just done pirate week where we try to planning for more creative curriculum.

[00:29:19.07] Em, and, em, in September we're coming back and we're gonna do three weeks of discrete teaching for a settling period. Cos that's what we're used to and then we're planning three weeks of creative. Em, and then, perhaps, reviewing that at half term to see what we do after half term.

[00:29:34.22] I'm actually going to plan up to Christmas creative in the hope that the second three weeks are successful. Em, but obviously as the maths coordinator, what I need to look at there, is, maths coverage, em, and we feel that perhaps is the subject which, there may need to be some elements of discrete in spite of, you know, trying to make, to make, sort of, as much of it creative as possible and as much of themed and cross curricula.

[00:30:10.04] Em, so, looking at how we're going to do that, really. Em, and also avoiding the tedious links. So, just doing a worksheet with a picture of pirate on because it's pirate week... So, em, what did we do? We all, during the pirate week it was really interesting because we all had different ideas for maths. Em, Denise's (unintelligible word) thing was 3-D shapes and they were looking at treasure, making treasure and different shapes.

[00:30:40.27] Em, I did weight because I was looking at weight and treasure. And so we all got something different from maths out, which surprised me because I thought, oh well, you

do weight if you do pirates and you do maths you do weight obviously. And then actually every body else had a different idea so I think there, perhaps, are more opportunities to avoid the discrete than you can, perhaps, imagine at first.

[00:30:59.01] And it's just, perhaps, getting into that way of thinking. Em, perhaps not planning on your own but saying to other people, you know, how would you do this, how would you that.

[00:31:09.27] Em, how many, ..., what form is this?

[00:31:11.11] We've got five classes, em, because we're a lower school we only go up to year four. So we've got reception...

[00:31:16.04] So it's just one...

[00:31:16.18] One form entry, yeah.

[00:31:19.09] Good, so, let's talk about the environment. I can, sort of, see... do you have, do you, do you feel that you've got your ideal maths environment? Em, would you try and create a part of that, I mean, obviously you've got to think of nine, ten other subjects, em, but, what do you try to evoke in your own classroom as an environment that's, em, conducive to learning mathematics?

[00:31:49.15] Em, I want maths resources that the children can go and help themselves to. I want them to think, I can't do this in my head so I'm gonna go and pick this up and use it.

[00:31:59.15] Em, and, sort of, perhaps not the class I've had just, but the class before that, it was the less able children they'd go and get the number lines and things. The class I've just had, it was the more able children, they'd feel more free to go and get calculators and protractors and things.

[00:32:15.17] So, I'm not quite sure... I think that's something I need to work on so that the whole is doing that. And getting different resources. Em, what I do think I cracked last year was, perhaps, one child would go up and get calculators and six children would go up and get calculators because he's got a calculator and so I must need one. So, it was well, do you want it, is this going to help you? And I think we, sort of, got to that.

[00:32:35.27] So now I'd like, I'd like resources to be more freer than they have been, which partly is classroom organisation but more is letting children know that that's OK and they can and they should. Em, and perhaps even modelling that. Perhaps even be working on something on the board myself and thinking, Oh, I need this and...

[00:32:52.06] So that's something you're thinking about as developing yourself. I know, sometimes, your best intentions, you make these plans, don't you, and it doesn't quite come off as you like. But that's great, thank you.

[00:33:02.08] So, on your walls, do you have, sort of, a regularly have a maths or a, em, er, board display? I notice you've got a times table...

[00:33:13.13] Yeah, em, if I.. what I did have - it's only just been taken down (laughter) - over there was a calculation board, so there was the four operations and there was the different ways of doing them depending on what suits you.

[00:33:26.19] Em, looking at (I can't tell what she is saying) some of them would be just looking at two digit numbers or adding nine by adding ten and taking away one but then going up decimals with different examples.

[00:33:38.20] So that's this one here...?

[00:33:39.29] Yeah. Em, we had, em, I'd given them menus and they'd done some maths work, I, I'd done some pictures of teachers and said Mr Johnstone and Mrs Whitehouse are going out for a meal but they've only got twenty-five pounds, what could they have? Em, I then gave them, they had different challenges, so how many different meals could they have, how many different variations, have they got enough for a drink each and things like that. So that was up on the wall somewhere with pictures of, em, restaurants and things.

[00:34:07.27] (Looking up at clock) By the clock there was just, em, flash cards with the months of the year. All things to do with time, months of the year, days of the week and things like that.

[00:34:20.18] We had a calendar here, which I encouraged the children to use and they go and put their own birthdays on, and when we've got the fete they go and put that on. So they try to use the calendar a lot, and there's another one over there which they can use, so there's two for them to pick up.

[00:34:31.15] Em, we do a football project, actually, which is really interesting. Em, the football project is, we use it all through the year. They pick a team, em, and it's, sort of, ICT and maths. They have a sheet that I give them that they have to turn into a calendar, so it's just boxes. They have to fill, they have to use the calendar to find out the first of the month, so Wednesday, Thursday and then they turn the sheet into a calendar. Then they go onto the internet and find their team's webpage and they put in all the fixtures and then they go back and put in the results and things like that.

[00:35:07.22] So they don't realise their reading information from tables. They don't realise they're learning about months of the year and days of the week...

[00:35:13.11] So that's all the class do that?

[00:35:15.00] Yes they do. They do that as mixed ability. And they discover things for themselves, such as the days of the month and if the first of January is a Monday then the first of February isn't going to be. They discover all those sorts of things together through lots of talk.

[00:35:27.18] Yes, just by using it..

[00:35:28.13] Yeah, yeah

[00:35:28.29] Lovely. And is that done, presumably that's done autumn or spring term...

[00:35:35.18] We start that when they first... I've done it for two years now and we'll do it again this year. We start it when they first come back, em, and it's one of the things, cos it needs a lot of input when they first start it. And then it is just something they can just go and get on with and then I can go and work with different groups of children and see where they're up to and....

[00:35:49.16] And is that, sort of, done over a period, obviously it's done over a period of time because of the different fixtures and results and what have you, but is that part, would

that then become part of their homework, or do you allow, sort of, a, em, I don't know one day, er, a week or ten minutes in a week to ...

[00:36:05.15] We tend, I tend to try plan it once every three or four weeks, cos then there's enough information on the computer to fill up the time to do it. Em, the first year I did it, two years ago, they were a really football orientated class. We did a whole football project. This year they haven't been, so, so we've just stuck with that. Em, and I'm not sure what I've got (can't tell what she says).

[00:36:24.09] No, you don't know until it happens, do you, really. Em, I know, cos, I would do that sort of thing but, em, I know I can hear colleagues now saying, yeah but what about the girls? Do you find that the girls are less interested?

[00:36:35.28] No because it's tabular information and it's organised and it's....

[00:36:40.25] That's quite interesting with their dads and their brothers I suppose

[00:36:43.05] Yeah, and then they can go home and engage in a conversation with dad about football, whereas....

[00:36:49.05] Great, thank you. Em, OK, so now I want to talk about your teaching again. Em, and I want you to really think about the whole class together. Em, because there are obviously different phases of a lesson, if we broke it all down and there'd be some times when you'd want to work independently, sometimes in groups, if you said, and you use talk partners. But there are times when you have the whole class engaged with you. You want them to be engaged with you alone. And obviously that's a part of the beginning, the starter, it's part of your main, perhaps the main teaching, and it may be one, er one, two three plenaries that you might have throughout the lesson. Em, that whole class bit, that whole class phase, what do you think are the important things about that whole class? What do you see as its strengths and what do you see as, perhaps, disadvantages? Could you explain...

[00:37:47.00] Em, I think the strengths are, I think it's really important for children to learn from each other and the peer interaction. And you're in the whole class situation and you're one child, the twenty-nine other children you can be learning from in that situation. Em, I think if you can get it so the children are, feel that it's OK to put their hand up and say, I don't understand. Then that can rub off on each other, em, and they can see maths as something that, this is what they know and this is what they're learning and it's OK that they don't know it yet.

[00:38:19.10] Em, so you can, sort of, get that relaxed attitude with the whole class bit by children saying they don't understand. Em, I think in terms of ability that can be quite tricky because you don't obviously want the lower ability children to feel like "I'm so far behind the higher ability children".

[00:38:42.20] Em, so you need to aim everything at everybody. And, perhaps, you know, the class I've got coming up are, I'm going to have two children who we're applying for statements for, so the differentiation is quite vast. So it might be, you could be working with decimals, em, and you could be talking about tenths and hundredths, place value, but then you need to write a nine, so you might ask one of your lower ability, can you come and write the nine, and that could be quite an achievement for them, if they get the formation right.

[00:39:09.07] So you can involve all children in all aspects. Em, what you don't want to do is lose those lower ability children because there's too that they don't understand what's going on. So that can be quite tricky to handle.

[00:39:23.27] Lovely, great, thank you. Em, I wonder if you could talk a little bit more, perhaps, about the pairing and grouping. Em, obviously in a whole class, em, phase you talked about, do you have them on the carpet, for example?

[00:39:56.23] Usually, yeah.

[00:39:56.24] And so they have their talk partners on the carpet. Are they the same talk partners, perhaps, you would have if they were at their desks or do you not use talk partners ..

[00:40:05.19] Em, we do. Em, we tend to choose their talk partner and that's their talk partner three weeks in all subjects and everything they do. Sometimes I will change that for maths, and other subjects, but usually more for maths. Because sometimes I will want them to work with the same ability or sometimes the talk partners, some of them come out the same ability and I want them to work in, em, top, middle and bottom.

[00:40:30.26] Em, so sometimes I will change those. Em, more often so that they're working with the same ability. So I'll just say, work with a partner on your table, because they're, the table, the maths tables, are the set ability tables.

[00:40:45.03] Right, so, em, obviously you find pair, you use pairing quite a bit... Obviously you see the advantages of that, em, you have group work as well, sort of, in there, if it was a paper or a practical they might be working in a group, they might be working in pairs, or do you not mind, sometimes? Do you, do you, sort of, have specific things, that you say, right, I want you all to work independently for this, obviously if it's a test or something, they will be working independently, but em, you know, are there, do you mind if they work together? If it's just not ....

[00:41:19.18] Em, again it would depend on what we're doing. Sometimes I want them to work in a group, sometimes I want them to work in pairs, sometimes I want them to work individually and sometimes I will give them that flexibility of choice.

[00:41:30.22] But you, kind of, instruct that...

[00:41:31.17] Yes, yeah.

[00:41:34.01] That's great, thank you. Em, if we think about the, em, well, we've got the curriculum, the 1988 curriculum, or two thousand as it is now, em, and we've got a new one coming out. But the Strategies have since, well, nineteen ninety nine, have been in with us for quite a while, em, do you see those as, em, the Strategy in numeracy particularly as a strength to support your teaching or to, I mean, maybe you've been on some courses recently, and you thought, they've been really informative and help me develop my teaching. How have you, sort of, felt about them as, er, a guidance which they're supposed to be....

[00:42:22.03] Em, the older strategy or the new framework...?

[00:42:22.13] Any, any Strategy. I mean, if you got, obviously when you started, em, there was, the Strategy was the, sort of, new thing really. Em, and did you find that useful as a new teacher?

[00:42:33.01] Yeah, I think so. Em, I think, with the Strategies it depends on they're used. Em, and with the older Strategy, with the examples, that was always really useful. I think where it could be misused, I mean, I know I went into a middle school to do a teaching practice and planning was literally the objective from the page of the Strategy and then she's just look at the example, model it and the children would do it. And that was it. That was their whole maths curriculum. And I just thought that was awful.

[00:43:00.08] And she was a maths specialist. So, em, their...

[00:43:06.13] So you weren't impressed then?

[00:43:07.21] No! (laughter) Em, they're useful in terms of examples, especially for people who are less confident with maths. Em, but I think they can be restrictive for teachers that will stick to them.

[00:43:20.01] And what do you think of the new framework that came out, well, a couple of years ago now?

[00:43:22.14] Yeah, em, we didn't start using that straight away. I preferred it, I felt it was less restrictive in that sense, em, I think it's more restrictive in a different sense. Em, just in terms of the units and the objectives within them, I may teach this lesson, this lesson and this lesson and feel like, em, I want to go up and teach this next but that's not within that unit. Em, so I do come away from that. And I do. I think, you know, the teacher is the expert so if you feel this is what this class need, just because the Framework doesn't say year four do this in term two block C, doesn't mean you shouldn't do it.

[00:44:06.13] Em, and again, perhaps teachers who are less confident with maths, I, I don't think I have got a grip on that Framework enough to know if, if they taught it anyway, if that would, sort of, be what I would consider adequate. You know, I think, I feel I need to come away from it so, perhaps, everybody should. But I know that's hard when you're not confident. I find that harder in other subjects...

[00:44:32.19] Yeah, each to our own really. We've all got expertise haven't we? Good, thank you. Em, so, just thinking a bit more about differentiation, you obviously have children in, just remind me, you've got the groups, you've got ability groups at tables

[00:44:48.11] Yeah

[00:44:49.26] Em, and that's where they usually work, or always work, at those tables. Do you ever mix those groupings up at the tables?

[00:44:59.08] Em, yeah, sometimes. Em, we have five groups and so we plan five ways.

[00:45:06.10] Wow, that's quite a lot, five groups.

[00:45:10.25] Em, and it can be as flexible as it needs to be. Em, for example, my top group are purple and my next group are orange and there were two children last year, and I just wasn't sure where to place them, so I gave them the choice. I said, everyday I'm going to tell you the purple task, I'm going to tell you the orange task, you choose. And what was nice was they would challenge themselves, they'd never chose the orange because it was the

easy option. They'd choose the purple if they felt they could cope and more often than not, but sometimes they'd choose orange if it was a bit tricky..

[00:45:39.07] Did you try that with any of the other children?

[00:45:41.00] I just tried it with those two children I wasn't sure of. What I have done a bit more of, em, this year, what I want to do more of next year, is differentiating with (maths you could?) I don't know if you've come across yet. So, completely saying, not using this terminology but this is the easy task, this is the medium and this is the difficult, you choose.

[00:46:01.21] And letting the whole class choose. That was really interesting, em, the, sort of, the children I've got who are, well the one boy particularly who was, sort of, a behavioural issue last year, completely challenged himself completely and said, well, I 'm doing that. I'm doing the top, the difficult task. And had I set that for him, and said this is what you're doing, he would probably have gone, no I'm not.

[00:46:26.05] But because I said you can choose what you do, and he had some of the ownership and control, he was happy to do that..

[00:46:31.21] Em, so you're going to experiment with that

[00:46:33.21] Yes, definitely.

[00:46:34.02] That'll be interesting, I shall look forward to that. Thank you, em, brilliant. So, cos you talked about in the whole class phases the differentiation and you try to involve them, so, em, you feel it's really important to have that interaction to differentiate? Is that right? Em, so that's through, could you just, sort of, say how you do that perhaps a little bit more...

[00:46:59.00] Em, differentiation in the whole class. I suppose, you, at the planning stage you really need to think about what your objective is and where each child is within your range. Em, in terms of that. And making sure you include some of that for every child. Em, and not necessarily (can't tell what she says), I suppose when I was first teaching I started off with the easy questions and get harder and harder and harder, perhaps going back and forth a bit more so that, you know, you don't know, right the first five questions are gonna be for me and then I can close my eyes and pretend to be listening, sort of thing.

[00:47:35.16] Em, so that the children know that, I think, I think they know that some things are aimed at other children but they know that they could be asked at any time. Em, quite often if it's working on the board, we would be modelling what they're doing in their books. And so modelling that, the different stages at which I want them to be working at.

[00:47:55.27] And perhaps, then, showing the links. So, thinking about paper exercise, addition number lines, perhaps doing one that the middle group would do, then coming and looking at the bottom group and, perhaps, saying it's the same as this because... and showing them the links between mathematics and, so then, even though they're working on this, they've been exposed to where they're going to be going and perhaps working in a few months' time.

[00:48:18.21] Great, thank you very much. That takes some time, doesn't it?

[00:48:22.14] Yeah (laughter)

[00:48:24.13] Do you feel you have the time? Or do you make time, sometime

[00:48:30.04] I feel like I do have the time, em, more so now I have the experience of teaching. Em, I, I think going for the, sort of, AST role, perhaps one of the things that would put me off would have been the, sort of, the day out of the classroom doing outreach work. And then somebody else have that literacy lesson and that numeracy lesson and, em, but

[00:48:50.00] It's all about control (laughter)

[00:48:52.05] Absolutely. Em, and now I feel that, em, to be, sort of, to be able to have that over and just have the four numeracy lessons a week would be OK. I am a bit dubious about coverage and time the creative curriculum coming up. That's something we're really need to think about.

[00:49:11.08] Em, it's challenging, isn't it?

[00:49:11.26] Yes, yeah.

[00:49:13.28] To try and get, as you say, the coverage and ... everything. OK, so we've nearly finished. Describe a topic in maths you wish you could teach more of. And say why.

[00:49:31.03] Em, a topic to teach more of...

[00:49:39.20] Perhaps there's not, but

[00:49:42.10] No, do you mean a topic in terms of how...

[00:49:44.13] Anything you like, any in mathematics, obviously...

[00:49:47.09] I think more, just, em, and this would possibly come from the creative curriculum, picking something like Fibonacci and doing fifteen things revolving around that. So, almost taking the progression away a little bit and just looking at maths for maths sake.

[00:50:06.22] Why do you think that's important?

[00:50:09.08] Em, because, I think those children that don't have a natural love for maths can learn to respect it and can learn to admire it. And I think we plod on with the curriculum and we plod on with, OK, we do this, now we need to this, now we need to do this. And, actually, if we were to take the time to stand back and look at maths and what it can do and the power of it,

[00:50:30.19] And, em, not impose, that's the wrong word, but give children the chance to see what it can do, then when you go back to doing the more progressive stuff, they'll be more enthused about it.

[00:50:42.13] Lovely. That's a nice way of putting it, yeah. It's about exposure isn't it.

[00:50:48.14] Yeah, absolutely.

[00:50:50.23] Yeah, that's interesting. OK, well, the reverse of that, what do you not enjoy teaching?

[00:50:54.28] Em, time! (laughter)

[00:50:58.18] Ooh, can you say why (said with irony)?

[00:51:01.13] Em, I just think the parents should. That's an awful thing to say, I think because children come with such...

[00:51:06.21] It's not maths, is it, really?

[00:51:06.35] No! (laughter) Such different experiences,

[00:51:11.09] Yes, yeah

[00:51:13.16] Em, and you, generally speaking, although it, sort of, changes with number and data handling, your top children are your top children in the maths room and you come to a time when it's all changed, em, and I just think, in order to teach time, it has to be. I always compare it to potty training

[00:51:32.15] (Laughter)

[00:51:33.19] You have to just, it has to be consistent and if, I just think if I had children and I, I felt they were ready to learn time, I'd do it home all the time for a month and they'd probably, most children would pick it up. And we do that at school, we do, do OK, it's time for assembly, where's the big hand? When the big hand's on this it will be this time and.. but I just think they almost need that reinforcement at home as well. I don't think we've got the time to teach time, they need the... you know, there's things like, OK, well, Eastenders finishes in half an hour, that's bed time or, you, and all those things that you can do at home.

[00:52:06.03] And I think that's how I learnt time. I don't think I learnt it at school, I think I learnt it at home. Em, and again, it's just, it's obvious isn't it? It's half way round the clock so it's half past. So why don't they understand (laughter) something simple like that.

[00:52:20.26] Did you feel that, em, cos this is a pet hate of mine, always has been since I taught it in every year, but do you, you kind of, this, this curriculum was developed, sort of, back in the eighties and what have you, but the way that we think about time is, OK, we have to use the analogue clock first, but actually, in today's world, that is inappropriate.

[00:52:47.04] Yeah, ....

[00:52:47.05] And I just feel that actually the curriculum should reflect today's world. And I don't think it currently does. I'm hoping that the new curriculum will reflect that. I'm told that it will but whether or not I don't know. But time, yes, is a pain, isn't it. Brilliant, the last question, thinking about the new curriculum, is there anything in the new curriculum that you will hope will be there? That isn't there or perhaps more guidance on or, just anything that you can think of, I just hope that that's going to now be, you know, compulsory for every teacher to do this or, you know, I have more freedom, to do...

[00:53:27.26] Yeah, I think it's the freedom, definitely. The freedom to be able to teach your children what you think they need. Em, what I teach the group of year four children I've got up, coming up, will be very different to what I taught the group last year. I mean, there will be some similarities, like we're going to do the football project again because they enjoyed it and I think it's nice if they enjoy it. But, em, again, going back to the Fibonacci work we do, they all loved it.

[00:53:53.02] Em, we did some outdoor maths and I just, I think you should go outside for maths, not just because of the nature aspect, we did, em, we did a Carroll diagram on the floor. We made a giant Carroll diagram with rakes? And I'd done it in the classroom before, in this space (showing the space at the front of the room) but we did it on the play ground in a huge space.

[00:54:13.00] And they were working with partners and I was changing the categories and they were taking the whiteboards with the numbers on and putting them where and finding the wrong ones and I was moving them about...

[00:54:19.02] Lovely

[00:54:21.18] And the children, I thought that that would hit on the children, I perhaps had a boy last year who wasn't, who wasn't diagnosed autistic but definitely, I had a visual timetable for him as he was, sort of, that way inclined. Em, and I had a boy who found it just so difficult to sit still and a girl who was a typical boy in that sense who found it very difficult to sit still and I thought they would be gripped by this, and they were.

[00:54:45.24] But the children who surprised me were two girls, one who's just very unconfident in everything she does and the other girl, who we talked about earlier, who's uncomfortable with maths, and they were just going off and doing it and they weren't looking to me for reassurance, they weren't unsure, they were just engrossed in what they were doing.

[00:55:03.04] Em, just because, and, you know, if I'd done the Carroll diagram on the board, they wouldn't have put their hand up, they wouldn't have offered an answer. If I'd have asked them they'd have looked a bit, ooohhh. If we'd done it on the carpet, even, you'd almost expect it to be the same, they wouldn't have been so sure. But when it's this big space, nobody's really watching you, em, they...

[00:55:20.19] So do you think it's about being watched?

[00:55:21.28] Yeah, I think it's about being put on the spot. And, em, because with numeracy it's the right or wrong answer thing, you know in literacy, give me an adjective I could use here?, there are fifty answers, probably ten or more appropriate than the other forty or, but with maths there's only one right answer. So, if I haven't got this right, it's going to be wrong, everybody's going to look at me, everybody's gonna know I 'm wrong. I think that is an aspect of it for some children.

[00:55:47.02] Great. Thank you, that's it.

## Appendix 3.4

### SRI interview transcript (example of Caz)

#### Appendix

SRI Interview transcript example

ECF SRI L2

[00:00:09.14] Interviewer: It's a lesson on time...ermm... and you started at - 1:15mins, because you asked them to remind you what they were doing... [WATCHED VIDEO]. I just want you to tell me... one the screen you've got time left 2 hours... Can you just tell me what the screen is, what that is...Why it's there and...?

[00:01:14.28] Teacher: Yes it's 2 minutes 15 and ermm... it's an interactive timer that I use to ermm... it's just actually a class management tool that I use. So that when they come in in the morning, ermm... I set the timer and it's visual, so they've got... it's counts down. ermm... and also there's music with it as well for well things they like, like Dr who and Indiana Jones and those kinds of things as well. So it's that sort of... you've got to be ready by... 2 mins 15.

[00:01:50.14] Interviewer: Brilliant thank you very much. [WATCHED VIDEO] Can you just describe that to me... I did notice you kept looking at the camera this time... Did you notice?

[00:02:22.16] Teacher: No Do you think it was there instead of there (pointing to the area the camera was set up in last time). I think I automatically look that way. I don't know.

[00:02:32.07] Interviewer: It was very different from my last video -taped lesson...(YEAH) Now you've put on a, like a target board. On a 5 x 5 grid with different times on ermm... and you asked that question...[WATCHED VIDEO] 'what can you see on the screen?' yes on the grid. yeah. So can you tell me why you asked that particular question? What can you see on the screen?

[00:02:59.23] Teacher: Yeah I didn't want to lead them in any way. I just wanted them to tell me anything they could at all about... about what they could see really.

[00:03:14.24] Interviewer: Then you followed it..[WATCHED VIDEO] 1:15mins.

[00:04:03.07] Interviewer: Right so you asked them ' What did we do at the end of last week?' and then you said , you saw a few hands and you then said 'I can see a few hands...' and you followed that with... 'I can see some people are looking in the right place'! Can you just explain what you mean, what you meant by that?

[00:04:18.25] Teacher: Yeah, ermm... the learning objective was, is displayed always above my head. But I didn't say it straight away because some people, some of the children were able to remember anyway. And then when somebody did look in the right place just to get maybe a few more hands, a few more children thinking about it, that's why I asked.

[00:04:39.23] Interviewer: And so generally you have your learning objective... do you always have your learning objective on the board above your head?

[00:04:45.24] Teacher: Yeap

[00:04:46.08] Interviewer: And do you do you explicitly say what the children will be learning, or do you a combination of you and the children, or do you always get the children

to.. some how... whether it's You know... it's something about progression of the lesson before or whatever...

[00:05:03.28] Teacher: Hmmm when it's the first lesson I would normally write it up and we'd pull it all apart. Looking at all the words and what they mean and... and what exactly that is and then... from then on... because the learning objective will stay the same for a period of... a few lessons, maybe even a week, and because the context is taken out of it so... if it was... well... we can... we are learning to measure time. So it doesn't matter what they are doing, they are still learning to measure time so then the next successive lesson I would expect that the children would be able to tell me... (silence)?

[00:05:45.05] Interviewer: What they'd been doing? (yeah...). ermm... then you put on target grid of times ermm... is that something that you... you developed, or is that something you... [WATCHED VIDEO] Right so can you just talk to me about this particular grid, why you chose... did you write it? and why you chose those things?

[00:06:30.11] Teacher: Yeah I got the idea from ermm... the strategy one of the excel spreadsheets. It's called number boards I think... and they have one for time which is twelve hour digital or 24 hour digital. so what I wanted to do with mine, is make it hugely differentiated going from O'clock all the way to the nearest digit digitally, so You know... the one that I found although I liked the idea, and the fact that you could do so many different things with it they wouldn't.. not all the children would have been able to access it.

[00:07:16.16] Interviewer: have you used this sort of thing before, or is this the first time you've....

[00:07:18.22] Teacher: Yeah this is the first time I've used it.

[00:07:19.27] Interviewer: Oh right. And did you think that it was successful?

[00:07:21.17] Teacher: yes I have used it again since..

[00:07:21.27] Interviewer: Oh have you?

[00:07:24.11] Teacher: Yeah... (both laugh) Because I used it for something different as well. 'cus you could use it for anything I think couldn't you!

[00:07:28.14] Interviewer: Yes. So the learning intention of this, could you just talk me through what those learning intentions are for using this. you say it's highly differentiated could you just tell me how and in what way... and what those aims of your were?

[00:07:41.19] Teacher: Yeah well the idea was that it would ermm... the children would pick a time and ermm... display that on a small clock. To their partner, and then their partner checking it... and making it into a game. So it just makes it a bit more exciting a bit more fun. So the.. really it was about them as this was part of the progression, what I hoped is that if they were doing quarter past the previous lesson, then they would have thought oh look I can see quarter past seven, I know that one so I can do that. Oh and I did O'clock, a couple of days ago, I can do that one... ermm... so really it was clarification of what they'd done before. I would expect.

[00:08:23.22] Interviewer: And you took what... I mean I think you ... introduced it and got a child up, could you just talk to me about why you chose child to do... Because we talked

about a similar thing on your last videoed lesson, could you just talk me through why you decided to present it that way?

[00:08:44.17] Teacher: It's... it's showing them how to do it. So modelling the game, rather than just telling them how to play the game, so they can see it in action, really, and they can see a child doing it so... if anyone is sitting there thinking 'I can't do this' then they can because Sophie could (laughs). So it's You know... them actually watching the game being played, which I always find... it just seems to work better otherwise, if you just explain, how to play something you just get a lots of children throughout the course of the activity 'I don't know what to do!...' 'we don't know what to do!'. and then they time's just wasted then really.

**PRELIMINARY THOUGHT: Contradiction here with her idea of modelling and demonstration telling vs showing? An interesting thought that modelling a game is better than explaining a game!**

[00:09:27.24] Interviewer: And so the process was, you did this little activity with Sophie, and then you gave it to the children and asked them to work in pairs. Will you just talk to me a little bit about again about the pairs.. were they the same pairs that had been before, or were they different pairs? did you choose the pairs, how were they?

[00:09:45.12] Teacher: they are ermm... talk partners, so mixed ability pairs. they might have been different to last time as we change them every 2 -3 weeks. I think they were actually different to last time. ermm... and so yeah... and that's another reason for having such a widely differentiated task, because it was the whole class and ermm... they were in mixed ability pairs so they were both persons in the pairs have got to be able to access the task.

[00:10:17.29] Interviewer: And you handed it to them... You gave them a good 5 mins or so. (Hmmm) Could you talk to me about the timing of that, was it your intention to give them that amount of time, and if so how did you think...I mean do you know how long it might take or did you choose to ermm... stop it at a particular moment or had you in your head going to stop it after a while?

[00:10:44.12] Teacher: Yeah well I know that they're generally a group that will engage for if they're interested in something, then they will engage. For 5 or ten minutes even. ermm... I didn't want it to be ...as it was consolidation, I didn't want it to drag on, I wanted them to move on, in that lesson. So I thought 5 minutes was a good opportunity to get into the game but not for it to drag on and take too much of the rest of the lesson really.

[00:11:16.14] Interviewer: Because it wasn't just the fact they had to show each other and they make that decision, about... I mean how successful do you think is, that they are in mixed ability and one child is perhaps not as far on, not necessarily lower ability of course... but ermm... how they are using time. If one child has done say ermm... 11:23 and the other child was working on quarters, ermm... how could,, I mean 'cus you could over hear things, how did you feel it all went?

[00:11:54.02] Teacher: I think there is always the chance that You know... the less able child would just say yes that's fine... because they perhaps know that child is good at maths or is confident, ermm... but I'm not sure that that really... really matters too much 'cus they're still both engaged in the game both of them are and the chances are the first child has got it right anyway, and unless they are playing the game and... the the ... lower ability child is

accessing that within their group. They're not accessing. SO they get to see what that 11:23 looks like You know... from a different person not just from me.

[00:12:41.26] Interviewer: And you had a bit of a competitive element here as well (both laugh). Which was a bit like connect four, or five in this case. Is that something you decided to put on later, or is that something that you thought 'oh no I could do that with this'?

[00:12:55.25] Teacher: Yeah I think whenever.... I always tend to look for the game in things really. Because it's fun for them and they enjoy it more when they think it's a game so... I just thought... well I looked at it and thought 'ooh I could make this into a four in a row, five in a row in this case, with this one.'

[00:13:12.25] Interviewer: Right thank you very much. that's great. You asked the children why the times look differently. 17:13mins [WATCHED VIDEO] Can you talk to me just what you were doing around, as you didn't sit here all the time you did sort of move around... can you remember the sort of things that you picked up? ... I mean that may have been your judgement you use that time to look at what is going on.. but...

[00:14:18.00] Teacher: Yeah, but I 'cus I got twenty five I do have a partner. So usually I work with that person but then when they are doing something I have a wonder round. I mean I just, well it's normally erm... asking... it's sort of getting them to play the game correctly. SO that they are doing, they are achieving what I want them to achieve. So then if they are not checking each other's, I will say 'ooh how do you know she is right or do how do you know he's right' and that kind of thing. So keeping them, keeping not on task because they are on task... nut keep them focussing on the task I want them to do really.

[00:15:15.09] Interviewer: [WATCHED VIDEO] (to plenary at end of section) What made you come up with that answer ...sorry the question then.. not the answer.?

[00:17:03.00] Teacher: I think it was what I had been doing with Sophie. And the conversation whilst playing the game sort of... Jack had said at the beginning they were different times... erm... but we hadn't sort of... talked about the different format of the times.

[00:17:26.27] Interviewer: And so

[00:17:28.24] Teacher: And some of the children had been learning about digital time, so they did know that. But there were some children that hadn't got that far, so it probably would have best it had come at the beginning, but because I hadn't thought of it then, I thought I'd ask it then.

[00:17:45.19] Interviewer: And what so you.... so therefore you thought 'right I'll ask it now' erm... what were you hoping to get back from the children there?

[00:17:57.29] Teacher: I wanted some of the children to realise that there were digital times and what they looked like. And that there are analogue times, and what they looked like.

**PRELIMINARY THOUGHT:** Interesting that ECF assumes that all children do not or have not come across digital times outside the classroom??

[00:18:11.23] Interviewer: And just as an aside, what do you think about teaching analogue to children?

[00:18:18.06] Teacher: It's really hard. ermm... I have found that in the past that with the two it is really difficult. And so I always try to run it alongside, so when we move onto to say twenty to eight... we talk about that as 40 mins past seven first. and then.. .well I say to the children we can say that in a different way, how else... they can change them really.

[00:18:47.03] Interviewer: So thinking on higher level, say this new curriculum that's coming out. Do you hope it's still there?

[00:18:54.18] Teacher: ermm...

[00:18:58.17] Interviewer: And if so where?

[00:18:58.17] Teacher: I think it should be there ermm... but I think that the focus is on analogue and the digital comes in at year four... ermm... whereas they are more used to the digital times before that, and so that it should probably be the other way round really...

[00:19:22.07] Interviewer: Thank you. [WATCHED VIDEO] So you used Adam... did you chose Adam particularly because you knew he could answer?

[00:20:32.14] Teacher: I knew he'd done the digital time, but I did not know if he necessarily be able to answer, he might have forgotten he might not have remembered the vocabulary. He did, but I knew that ... that he'd been there and he had learnt about digital time.

[00:20:51.15] Interviewer: So you chose to ask a child to explain instead of explaining again yourself. Can you just talk me through why you chose a child and not to explain it yourself?

[00:21:03.08] Teacher: ermm just I think to show the children that You know... other children know it, and You know... it's not something only grownups need to know. I think that sometimes they just switch off if you just going on all the time (she laughs).

[00:21:19.08] Interviewer: You think that if they listen to one person, perhaps is that what you mean?

[00:21:26.02] Teacher: Yeah if it's all about explanation, rather than asking questions You know... 'cus if I just sat there and explained... for the whole lesson I don't think that they would engage. If I just talked (laughs again at the thought).

[00:21:47.04] Interviewer: Thank you. [WATCHED VIDEO] Just before we talk about the groupings... ermm... you quite a collection of digital, no I mean clock resources there... I mean you obviously wanted a whole class set. What do you think works, did you think they worked well having those, and are you pleased with what you get from the children with those resources. I mean in an ideal world, what would you like if you had any choice. Would that still be that sort of thing.

**PRELIMINARY THOUGHT: Question about the use of such a range of resources - clock faces. Some are plastic, some old cardboard.**

[00:22:35.29] Teacher: I think the ones we have work ok. The old cardboard ones, the hands slip sometimes. but it's ok if they're doing it on the flat. But when you tell them to show you, they slip. The plastic ones are too small I think, the faces are too small I think. I have since got some new ones, 'cus (she laughs) 'cus we don't actually have a complete set of either... so we've got some of the plastic and some of the cardboard ones. so I've just got some actually so, and they're ermm... they are cardboard but they are sort of laminated shiny. ermm... and they've got the ermm... analogue clock, which is about the cardboard size,

which is a good size but they have also got space for the digital time at the bottom, and you can write and wipe, with those ones. So...

[00:23:23.27] Interviewer: And they are both free hands or geared?

[00:23:27.24] Teacher: No free hands.

[00:23:33.02] Interviewer: and would that be your perfect...

[00:23:36.01] Teacher: ermm... the geared... It's hard... because you do sort of have to I do think they have to know that the hour hand is moving, and I think that with the geared clock it can be easy to just take it for granted, because it just happens. ermm... but then it is really, really hard for them especially once they get to, You know... you've done quarter past and quarter to, and you do your 5mins, and everything is going really great. And then as soon as you get to 1 minute time that's when the hands start going the wrong way, and that's why they get mixed up. and it's because it's almost as if there's too much going on. So in those situations, geared clocks are think are useful , but they are very expensive (laughs). I could have the small ones I did look into those,

[00:24:27.14] Interviewer: ermm...right and then you sent off the groups. Could you just talk me through your groups, because you had about four groups can you remember... [WATCHED VIDEO]. So you just had three in that group. ermm... can you just talk me through that group... and you asked them to try to remember what they were doing..

[00:26:14.21] Teacher: The ermm... day before. I had a bigger group playing a loop game. on the carpet, and those were the three children who didn't quite achieve what I intended the quarter past and quarter to, and I just felt that they needed another lesson bout with the same objective, and more support in a smaller group.

[00:26:41.24] Interviewer: and the next group was with another TA. Mrs Hodson's 17:25mins [WATCHED VIDEO]. So you did exactly the same with this group. You talked to the group, and asked them what did you do, what were you learning. SO is that something you would always do with your groups?

[00:28:10.20] Teacher: Not if they're, not if it's the first lesson. ermm... usually I do. Or I ask the TA to.

[00:28:22.13] Interviewer: But you wanted them to explain it rather than just remind them yourselves. Because of your voice thing?

[00:28:29.09] Teacher: Same reason really. And I want them to know that they need to know. I'm not going to, if I sit there and tell them every time and then they're never going to be able to say what they're learning to do. So if they know it's coming.

[00:28:45.09] Interviewer: Why do you say that, why do you think they'll never know, they'll never be able to say it?

[00:28:50.01] Teacher: I just think that if you say it everyday, you are learning to do this and the next day you are saying you are learning to do this... I just don't think they are necessarily going to take it in, because they don't need to. Because nobody is asking them what they're learning.

[00:29:01.25] Interviewer: And why do you think that that's important?

[00:29:04.12] Teacher: I think it's important for them to know what they are doing and why. You know... It gives it a purpose really. It makes them erm... it's hard to explain.

[00:29:25.19] Interviewer: That's alright, it was a deep question...

[00:29:25.19] Teacher: Yeah erm... I think it's just making them responsible for what they are doing. and if they don't know what they are learning, they just think of the activity and they do the activity and they go to lunch and the next day You know... it's gone. But whereas here they are thinking well if I do this today, tomorrow I can do this. Oh and yesterday I could do that. And it's you know, they can see at the end of a unit, what have, what can you do now that you couldn't do before? SO they can see... their achievement. I suppose.

[00:30:06.15] Interviewer: That's interesting because you've just said you want the children to remember what they've been learning and not the just the activity. Can you describe what that distinction is? For you what you mean by that? erm... they remember the activity or they remember what they're learning.

**PRELIMINARY THOUGHT:** This collaborates with DAJ's idea and CSS about we're not just learning about cake!

[00:30:28.21] Interviewer: Well the activity is just the means of doing the learning. The learning is important isn't it, that's improving your knowledge and your understanding. Whereas it could be done through any activity. And that's why when they say to me, like when Charlotte started to say to me earlier well we played this game in a circle, and that's fine that's good because you've remembered what you did but that's not the important part. It's the fun bit, but the important part is well what do you think you get from it. Which is that what the learning is, I think.

[00:31:00.01] Interviewer: Thank you very much. sorry, that was really good point thank you. And then at 18:30 mins you sent then next group off. So you actually had four groups going.[WATCHED VIDEO]. SO there was some very specific information you were leading them to. So that you wanted to actually identified... was this another board that you put together?

[00:33:19.20] Teacher: No no this one is from the strategy.

[00:33:25.10] Interviewer: So this was for a very specific group?

[00:33:29.16] Teacher: Yeah and a group I wanted to work independently. So I wanted them to be really clear about what I they were doing. Because erm... that's often why with the independent group I or independent groups, are often working on the same objective as the previous lesson, but consolidating that through a game or activity. Because I need them to be impudent. And if they get themselves stuck on things, then they're not going to be independent.

[00:33:58.22] Interviewer: No so erm... what does that mean for you at this point as you are sending each group off?

[00:34:05.08] Teacher: The group that I'm left with erm... I can focus on then, And I tend to stick with them for the rest of the lesson, including each group including the ones that are being supported, to make notes once my group are getting on with the task, but then I

would go back to them as well, as I would see them as my sort of... focussed group for that lesson.

[00:34:32.28] Interviewer: So do you feel you have to sort of... when you are devising your groups and the activities for them, so the independent group you think differently about?

[00:34:40.13] Teacher: Yeah I do definitely I do yeah.

[00:34:42.05] Interviewer: Can you say a little bit more about that?

[00:34:42.23] Teacher: ermm... They have to be given something they can do. That I'm confident that they can do, so introducing a new concept is not really an option. At that point. That's why I often get them to just do the same objective, but it will be a different activity. SO the day before they did it with support. And this day they're doing it on their own. So yeah.. You know... there still is that chance that they'll not be able to do it, but from talking to the TA the previous lesson, those children that are in that group still are the one that she has said 'yeah they're doing well with this, they're nearly there with it.

[00:35:28.22] Interviewer: Thank you yes. I pushed you on this one a bit...

[00:35:44.13] Teacher: Oh when he said oh Adam, said about to the nearest minute..

[00:35:56.20] Interviewer: it was about the easiest... [WATCHED VIDEO] because you said about the easiest, you talked about the easiest times.... What were you thinking then because you sort of... shifted him a little bit in thinking about what he was going to be doing next?

[00:36:27.00] Teacher: ermm... I think I suppose what he'd spotted... was,, I think he must of spotted something like 9 O'clock or something, and ermm... it didn't worry me, it didn't matter at all. ermm... but the focus was onto the nearest minute. SO he was being You know... really good. sort of... saying well if it's to the nearest minute why have you '00' or '15' or '30' because he was making that connection in that he'd done that before, You know... ermm... but I didn't think it was necessarily something that we'd need to get into. SO yeah he picked up something. which was really good.

[00:37:13.07] Interviewer: Lovely thank you very much. And then right... time differences... and you are using the matheletics game. can you talk to me a little bit about what that program is. Is it something specific for the school or?

[00:37:33.03] Teacher: Yeah you buy into it. ermm... and we bought into it for the whole school. I think it's about £9 a child and it's something that's an internet game, so it's something they can go into on at home. There's two elements to it, there's ermm... speed mental maths, where they play against children from all over the world. It came from world maths day, which is what they do then. and the other element is the course, where you put the child in a particular year group, and ermm... there are activities for sort of... different elements of maths. and they can also choose to do something easier, or harder. So what I was doing with those children was, time differences. Which was... I know what my objective was and it so happened that I looked on mathletics and they had something. Because i know they enjoy mathletics, so You know... it's just an exciting medium really. To sort of practice with.

[00:38:43.16] Interviewer: And you've found it useful and successful in your practice?

[00:38:42.24] Teacher: Yeah, it does ermm... is it hard with the computers because you do have the, I mean we do have laptops and we do get the laptops shut down. And my laptop the battery is flat, and with mathletics, it does freeze from time to time, and it's hard when they are on question 3 and it freezes and then they after start all over again. Although they different questions, You know... they have still got to question 3 and so it's not ideal, but I do think it's better than giving them 10 questions on a sheet, here you go get on with those. Because they earn credits and the account that they're on it's just a little bit of incentive really.

**PRELIMINARY THOUGHT:** Is this crashing freezing out computer game better than a sheet of questions?

[00:39:23.20] Interviewer: So you find it motivating do you?

[00:39:24.25] Teacher: Yeah I think so...

[00:39:29.23] Interviewer: That's the end of the whole class bit. But there are a few questions I would like to ask if I may about your ermm... just this little bit (group work). Yeah, it's interesting how you said that... [WATCHED VIDEO]. Did you notice when you were standing in front of the screen there was a lovely side view there (referring to her bump! Pregnant).

[00:40:00.08] Teacher: I look really big there gosh! I wonder what I look like now?

[00:40:21.27] Interviewer: [WATCHED VIDEO] Luckily this child moved slightly to one side so I could see the screen on your computer. (watches the episode where ECF intros the activity on computer). Right so you are setting it up... and you say 'I'm going to show you the way I would do it@, now why did you make an emphasis on 'I'm going to show you the way 'I' would do it?

[00:41:44.04] Teacher: ermm... because I don't, I don't mind how they do it, and I heard just Benjamin say that he would do it like that, and that's great, but I know that they are not all that easy (questions) and they might not be able to do all of them so, I'm showing them a method that works ermm... for them to sort of fall back on, because they will all try to do it in their head. Which is great. But if it doesn't work then they'll need another method. So that was what I was giving them.

[00:42:20.11] Interviewer: Great thanks very much... and the method was....?

[00:42:21.00] Teacher: Blank number line.

[00:42:23.20] Interviewer: Is that something you use a lot?

[00:42:25.01] Teacher: Yeah. All the time yeah.

[00:42:25.01] Interviewer: Why?

[00:42:29.19] Teacher: Well I think it's really visual, and it makes sense. You can really see exactly what's happening. And it's actually how you think it through in your head, so it's sort of... although you would use it when the question was a little bit too difficult to do in your head. It's the same sort of thinking, you are adding on an hour, you're adding on another hour and how many minutes are in-between, what's the difference. So it's that thinking from your head. but it's just giving you somewhere to record the steps so you don't forget I think.

[00:43:05.05] Interviewer: Thank you very much. 31:50mins[WATCHED VIDEO] ermm... Come on talk to me why are you laughing? (ECF is laughing quite a lot at this point whilst watching the video clip).

[00:43:59.09] Interviewer: Because Benjamin said oh please, oh please pick me... 'cus he's so keen. To give me the answer.

[00:44:09.01] Interviewer: So you asked 'what if... ' Because it's got hours and minutes on here as the time, can you just why you said that, why you asked that question?

[00:44:16.26] Teacher: I said that, I do this quite a lot, I think I just, I want it, I think the one thing I say all the time is... can you give that to me in another way. can you give me another word for that?

and it's just sort of... interchanging, the different things really and just making the connections all the time between the 60 minutes and the hour. And not forgetting that. Because sometimes... you are going to have to do it in minutes at some point... (laugh).

[00:44:46.11] Interviewer: Yes they did, I think they did struggle with the one later on didn't they. Right great, that's that. Now if I just ask you in your review... can I just ask you why you did something... At the end of the plenary, it was quite.... [WATCHED VIDEO]. Right you asked all the children the whole class, what they had been learning today, and ermm... now you have got the learning objective on the board, now are you expecting them to... is that a habit that you stand over in the middle of the room (not near the board).

[00:46:10.27] Teacher: Yeah at the end...

[00:46:11.09] Interviewer: why do you do that?

[00:46:13.06] Teacher: I just think it's I don't know why! ermm... You can see everybody, but there's I mean if I stood here gesturing to where we were sitting in the room, some of these children are quite far away. (It's an L shaped room really. Long and thin). So I would have to shout. I think I just stand here because if I yeah.... It just feels that everybody... it's the closest I feel I can get to everyone just there.

[00:46:40.12] Interviewer: Then you asked everybody so the LO is on the board. Do you expect them to look at the LO on the board to remind them.

[00:46:46.07] Teacher: Ohhh, well they can if they want to. I mean if someone stood up to have a look I wouldn't say sit down what are you doing. You know... that would be fine, but I kind of would expect them to remember 'cus we talked about it at the beginning.

[00:47:00.01] Interviewer: And you'd hope they would remember what they had been doing?

[00:47:00.01] Teacher: Yeah.

[00:47:02.16] Interviewer: And then you asked one child from each group, now is that ermm... is that planned for, is it that you wanted to get someone from each group, did you pick particular children from each group for example?

[00:47:15.08] Teacher: ermm...I picked... I usually pick the ones perhaps that aren't so sure at the beginning. So like Bradley, and Charlotte at the beginning, he didn't put his hand up, so I wanted to just be sure that, You know... ok you didn't know it at the beginning, but you

know now don't you so that's great. that's why. And if I can't if there is nobody that stands out like that then I will just be quite random about it really.

[00:47:43.08] Interviewer: And then you asked what's coming next....Or did you say what's coming next [WATCHED VIDEO] Ah yes, so can you just talk me through, because you alluded to that earlier?

[00:48:04.23] Teacher: Yes as well as the children sort of clarifying in their own minds what they have been learning. I do that at the end so that the other children can see what their next step is, in that lesson. They can see that oh yeah that group over there have been doing 5mins I'll probably be doing that next lesson. Now it doesn't really matter to me if they can't work it out exactly. Especially the more able they don't know what's coming next for them unless I'm working with them and I tell them. ermm... It's just that knowing where they're going with it really.

[00:48:46.29] Interviewer: So obviously this is one in a sequence of lessons, ermm... were you happy with where they ended up. (YEAH) the majority of the class, did they all move on, did you feel that they had.

[00:49:01.19] Teacher: I did pick up that the children who were doing the time differences, ermm... they did that independently, in the next lesson. ermm... that they these children here who were independently working here, and I had been round so they moved onto time differences as well, so they ended up just a bigger group really. ermm...

[00:49:25.01] Interviewer: You had more laptops and...

[00:49:25.01] Teacher: yeah and I think there was six of those, so we had a much bigger group. But the ones that had already started went off and got on with it. And the others had the explanation about the numberline and that kind of thing. I think there was a few if I remember rightly, that I noted down weren't using the numberline correctly or were relying too much on their head and not getting them correct, so they sort of stayed with this group and had the explanation again.

[00:49:55.27] Interviewer: Did you ask them to stay there, or did they volunteer to stay there.

[00:50:00.28] Teacher: I think I asked them, ermm... but I do usually ask is there anybody who wants to or thinks they want to. And they are very good at doing that and being honest. i just have to watch because with some children if they are not very confident who always say I think i need to listen again. and so sometimes I just ignore them. Not ignore the request but think well actually I know best at this point, and I saw what you did yesterday and you need to be a bit braver and just have a go on your own now. And you know who those children are now anyway.

END

## Appendix 4.1

### Semi-Structured Interview schedule (revised)

*Colour coding key: see below.*

|    |  |   |
|----|--|---|
| 1  |  | What attracted you to primary teaching as a career?   |
| 2  |  | Did you specialise in a subject?<br>Why did you choose that subject?  |
| 3  |  | What was your experience of mathematics like at school? Were they good or bad? What made them this?<br><br>What do you remember about your experience with school mathematics?<br><br>How would you describe the teaching you experienced?      |
| 4  |  | Were you inspired by anyone at school in mathematics (secondary or primary)?<br><br>Did anyone influence you in mathematics, or your views of mathematics?<br><br>What events or people have influenced your views on mathematics as a subject? |
| 5  |  | Thinking about mathematics teaching, What do you enjoy about teaching mathematics?  |
| 6  |  | Have there been any events or people that have influenced your beliefs about the teaching of mathematics?   |
| 7  |  | As a teacher, what aspect of mathematics do you feel is most important for your pupils to experience?<br><br>Do you think there is a problem with mathematics teaching in primary?  |
| 8  |  | When I video-tape a mathematics lesson, what do you think I might see?<br><br>What would be a typical (Teacher's name) mathematics lesson?<br><br>What would it look like?<br><br>Routines, resources etc.                                      |
| 9  |  | If I asked the children what I might see, what do you think they might say?<br><br>What do you think the children might see as a typical mathematics lesson in your classroom?  |
| 10 |  | What do you think your pupils think about the NNS/PNS 'style' daily numeracy lesson?<br><br>Would the children describe a mathematics lesson in parts?  |

|    |  |  |
|----|--|--|
|    |  | Would they comment on the structure of the lesson? Why?  |
| 11 |  | <p>The national strategy has been with us for some years now, do you think that mathematics has moved on now since a time before the NNS came in?</p> <p>Do you think it helps to develop mathematics?</p> <p>Do you think other teachers like the strategy emphasis/this structure?</p> |
| 12 |  | <p>What is your ideal environment for the learning of mathematics?</p> <p>Wall displays?</p> <p>Practical Resources – specific to topic? Calculation resources specific? Generic resources?</p> <p>Interactive White board resources?</p> <p>School/ personally owned?</p>               |
| 13 |  | <p>What do you see as the strengths of the National Curriculum for Mathematics?</p> <p>Weaknesses? Give examples?</p>  |
| 14 |  | <p>What do you see as the strengths of the National strategies (NNS/PNS) for Mathematics?</p> <p>Weaknesses? Give examples?</p>  |
| 15 |  | <p>Do you think the strategy framework(s) have a strong impact on what teachers do in mathematics?</p> <p>The way that it is taught? What is taught? And when?</p>   |
| 16 |  | <p><b><i>IF suggest a 3-part lesson:</i></b> What do you think about a 3-part lesson?</p>  |
| 17 |  | <p>For you, what the key elements of the oral/mental starter?</p> <p>Positives/negatives?</p>  |
| 18 |  | <p>For you, what are the key elements of the main part of the numeracy lesson?</p> <p>Positives/negatives?</p>   |
| 19 |  | <p>For you, what are the key elements of the plenary/review?</p> <p>Positives/negatives?</p> <p>Are they aware of the OfSTED emphasis on good plenaries/reviews?</p>   |
| 20 |  | <p>Thinking about teaching the ‘whole class’ together, what are the strengths of direct teaching with a whole class?</p>   |

|         |       |   |
|---------|-------|---|
|         |       | <b>IF Mention of</b> learning styles? Teaching styles? Examples?<br><br>What, for you, are the weaknesses of teaching the 'whole class' together?   |
| 21      |       | Do you use paired and group work in these whole class sessions?<br><br>What do you think are the advantages of paired work? Group work? for you, are the strengths of children working independently? |
| 22      |       | What for you are the weaknesses of children working independently?  |
| 23      |       | Describe a topic in mathematics you wish you could teach more of (one you feel is enjoyable to teach or worthwhile teaching)  |
| 24      |       | Describe a topic in mathematics you do not enjoy teaching or would not wish to teach?   |
| 25<br>a |       | <b>IF Teacher pre-1999:</b> Has your approach to teaching changed since the introduction of the NNS?  |
| 25<br>b |       | In your opinion do you feel the NNS initiatives (daily lesson, 3-part etc.) were for the better of 'teaching mathematics'?  |
| 26      |       | This past year the school's emphasis has focussed on numeracy. Do you feel the LEA-led INSET day was helpful?   |
| 27      | Green | A new NNS framework will be implemented next year. What do you hope it will include/change?   |

### Key to Categories:

|   | Theme   | Description  |
|---|---|--|
| 1 | Personal Experience - subject<br><br>Orange: Personal experience of mathematics including school experience (attitudes and beliefs about the subject personally). | Attitudes and beliefs of the teacher about the subject of mathematics  |
| 2 | Personal Views - teaching<br><br>Blue: NNS: Personal views on particular class dynamics (didactic strategy).  | Teachers' personal views on the teaching of mathematics  |
| 3 | Personal Preferences - teaching<br><br>Lilac: Personal Preferences of mathematics teaching.   | Teachers' preferences in the classroom dynamics and didactic strategies when presenting mathematics  |
| 4 | Personal Reaction - curriculum<br><br>Green: NNS: Reaction to current government expectations/recommendations   | Teachers' feelings about past and current Government expectations and recommendations e.g. introduction of and implementation of the NNS and PNS |

**Categories:**

*These are not exhaustive categories, there will inevitably be links and relationships made between the categories by the teachers in their answers to the questions. The following two are however, those that have been identified:*

1. Blue/green: Links between their views and expectations they might consider to be
2. Blue/lilac: Links between their views and preferences

## Appendix 4.2 WCI web



## Appendix 5.1

### Lesson Analysis: ELLIE Lesson2 Narrative TABLE Level 2

| Where are the children & what are they doing?<br>Resources being used etc.  | What Mathematics? | What is the teacher doing?  | What does the teacher SAY (believe) she/he is doing?   | Analysis and preliminary thoughts |
|---|-------------------|---|--|-----------------------------------|
| Children on the carpet in front of the IWB.<br>They are instructed to have a small card clock. And two wb pens one of blue one of black. They also have a small WB between the pair.<br><br>Child responds lots of times. | Time              | <p>Teacher asks what they have been learning about.</p> <p><b>Learning all about time.</b></p> <p>Teacher asks what can you see on the screen?</p> <p>Target board on screen with</p> | <p>[00:01:14.28] Teacher: Yes it's 2 minutes 15 and erm... it's an interactive timer that I use to erm... it's just actually a class management tool that I use. So that when they come in in the morning, erm... I set the timer and it's visual, so they've got... it's counts down. erm... and also there's music with it as well for well things they like, like Dr who and Indiana Jones and those kinds of things as well. So it's that sort of... you've got to be ready by... 2 mins 15.</p> <p>On a 5 x 5 grid with different times on erm... and you asked that question...[WATCHED VIDEO] 'what can you see on the screen?' yes on the grid. yeah. So can you tell me why you asked that particular question? What can you see on the screen?</p> <p>[00:02:59.23] Teacher: Yeah I didn't want to lead them in any way. I just wanted them to tell me anything they could at all about... about what they could see really.</p> <p>[00:04:18.25] Teacher: Yeah, erm... the learning objective was, is displayed always above my head. But I didn't say it straight away because some people, some of the children were able to remember anyway. And then when somebody did look in the right place just to get maybe a few more hands, a few more children thinking about it, that's why I asked.</p> |                                   |

|  |   |   |   |
|--|---|---|---|
|  | <p>Child responds in the middle of the grid.</p> <p>Recognise written times</p> | <p>times on.</p> <p>Teacher gives instructions that one of the pair will draw out a grid with 5 columns and 5 rows. She demonstrates on a small white board.</p> <p>She points to the board on the screen which also has 5 rows and 5 columns.</p> <p>Teacher plays the game with one child.</p> <p>Quarter past 7. Who can tell me where that might be displayed on our grid?</p> <p>Explains then she will make quarter past seven on the small clock, and she has to say if the time is right.</p> <p>Sophie is happy and so the T demonstrates that she places a blk tick in the grid position that quarter past 7 is</p> | <p>[00:05:03.28] Teacher: Hmmm when it's the first lesson I would normally write it up and we'd pull it all apart. Looking at all the words and what they mean and... and what exactly that is and then... from then on... because the learning objective will stay the same for a period of... a few lessons, maybe even a week, and because the context is taken out of it so... if it was... well... we can... we are learning to measure time. So it doesn't matter what they are doing, they are still learning to measure time so then the next successive lesson I would expect that the children would be able to tell me... (silence)?</p> <p>[00:06:30.11] Teacher: Yeah I got the idea from erm... the strategy one of the excel spreadsheets. It's called number boards I think... and they have one for time which is twelve hour digital or 24 hour digital. so what I wanted to do with mine, is make it hugely differentiated going from O'clock all the way to the nearest digit digitally, so You know... the one that I found although I liked the idea, and the fact that you could do so many different things with it they wouldn't.. not all the children would have been able to access it.</p> <p>[00:07:18.22] Teacher: Yeah this is the first time I've used it.</p> <p>[00:07:19.27] Interviewer: Oh right. And did you think that it was successful?</p> <p>[00:07:21.17] Teacher: yes I have used it again since..</p> <p>[00:07:24.11] Teacher: Yeah... (both laugh) Because I used it for something different as well. 'cus you could use it for anything I think couldn't you! you say it's highly differentiated could you just tell me how and in what way... and what those aims of yours were?</p> <p>[00:07:41.19] Teacher: Yeah well the idea was that it would erm... the children would pick a time and erm... display that on a small clock. To their partner, and then their partner checking it... and making it into a game. So it just makes it a bit more exciting a bit more fun. So the.. really it was about them as this was part of the progression, what I hoped is that if they were doing quarter past the previous lesson, then they would have thought oh look I</p> |
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| <p>Children asks a range of questions. One asks what if you get one wrong?</p> <p>Can we block?<br/>Child explains how he might block his partner.</p> | <p>Children have introduced a logical strategic decision on the game.</p> | <p>displayed.<br/><br/>She continues to explain that it is then Sophie's go and she picks a time and has to show it on their clock.<br/><br/>Any questions?<br/><br/>T responds you leave the position on the grid and can then have another go.</p> | <p>can see quarter past seven, I know that one so I can do that. Oh and I did O'clock, a couple of days ago, I can do that one... ermm... so really it was clarification of what they'd done before. I would expect.<br/>[00:08:44.17] Teacher: It's... it's showing them how to do it. So modelling the game, rather than just telling them how to play the game, so they can see it in action, really, and they can see a child doing it so... if anyone is sitting there thinking 'I can't do this' then they can because Sophie could (laughs). So it's You know... them actually watching the game being played, which I always find... it just seems to work better otherwise, if you just explain, how to play something you just get a lots of children throughout the course of the activity 'I don't know what to do!'... 'we don't know what to do!'. and then they time's just wasted then really.</p> <p><b>PRELIMINARY THOUGHT:</b> Contradiction here with her idea of modelling and demonstration telling vs showing? An interesting thought that modelling a game is better than explaining a game!</p> |
| Children in pairs  |   | 4mins to play the game – sets timer (7:23).  | <p>[00:09:45.12] Teacher: they are ermm... talk partners, so mixed ability pairs. they might have been different to last time as we change them every 2 -3 weeks. I think they were actually different to last time. ermm... and so yeah... and that's another reason for having such a widely differentiated task, because it was the whole class and ermm... they were in mixed ability pairs so they were both persons in the pairs have got to be able to access the task.</p> <p>[00:10:44.12] Teacher: Yeah well I know that they're generally a group that will engage for if they're interested in something, then they will engage. For 5 or ten minutes even. ermm... I didn't want it to be ...as it was consolidation, I</p>   |

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|  |  |   | <p>didn't want it to drag on, I wanted them to move on, in that lesson. So I thought 5 minutes was a good opportunity to get into the game but not for it to drag on and take too much of the rest of the lesson really.</p> <p>[00:11:16.14] Interviewer: Because it wasn't just the fact they had to show each other and they make that decision, about... I mean how successful do you think is, that they are in mixed ability and one child is perhaps not as far on, not necessarily lower ability of course... but erm... how they are using time. If one child has done say erm... 11:23 and the other child was working on quarters, erm... how could,, I mean 'cus you could over hear things, how did you feel it all went?</p> <p>[00:11:54.02] Teacher: I think there is always the chance that You know... the less able child would just say yes that's fine... because they perhaps know that child is good at maths or is confident, erm... but I'm not sure that that really... really matters too much 'cus they're still both engaged in the game both of them are and the chances are the first child has got it right anyway, and unless they are playing the game and... the the ... lower ability child is accessing that within their group. They're not accessing. SO they get to see what that 11:23 looks like You know... from a different person not just from me.</p> |
|  |  | Discussion about games with interviewer | <p>[00:12:55.25] Teacher: Yeah I think whenever.... I always tend to look for the game in things really. Because it's fun for them and they enjoy it more when they think it's a game so... I just thought... well I looked at it and thought 'ooh I could make this into a four in a row, five in a row in this case, with this one.</p> <p>[00:14:18.00] Teacher: Yeah, but I 'cus I got twenty five I do have a partner. So usually I work with that person but then when they are doing something I have a wonder round. I mean I just, well it's normally erm... asking... it's sort of getting them to play the game correctly. SO that they are doing, they are achieving what I want them to achieve. So then if they are not checking each others, I will say 'ooh how do you know she is right or do how do you know he's right' and that kind of thing. So keeping them, keeping not on task because they are on task... nut keep them focussing on the task I want them to do really.</p>  |

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|  |  |  | <p>[00:17:03.00] Teacher: I think it was what I had been doing with Sophie. And the conversation whilst playing the game sort of... Jack had said at the beginning they were different times... ermm... but we hadn't sort of... talked about the different format of the times.</p> <p>[00:17:28.24] Teacher: And some of the children had been learning about digital time, so they did know that. But there were some children that hadn't got that far, so it probably would have best it had come at the beginning, but because I hadn't thought of it then, I thought I'd ask it then.</p> <p>[00:17:57.29] Teacher: I wanted some of the children to realise that there were digital times and what they looked like. And that there are analogue times, and what they looked like.</p> <p><b>PRELIMINARY THOUGHT:</b> Interesting that ECF assumes that all children do not or have not come across digital times outside the classroom??</p> <p>[00:18:18.06] Teacher: It's really hard. ermm... I have found that in the past that with the two it is really difficult. And so I always try to run it along side, so when we move onto to say twenty to eight... we talk about that as 40 mins past seven first. and then... well I say to the children we can say that in a different way, how else... they can change them really.</p> <p>[00:18:58.17] Teacher: I think it should be there ermm... but I think that the focus is on analogue and the digital comes in at year four... ermm... whereas they are more used to the digital times before that, and so that it should probably be the other way round really...</p> |
|  |  |  | <p>[00:19:22.07] Interviewer: Thank you. [WATCHED VIDEO] So you used Adam... did you chose Adam particularly because you knew he could answer?</p> <p>[00:20:32.14] Teacher: I knew he'd done the digital time, but I did not know if he necessarily be able to answer, he might have forgotten he might not have</p>   |

remembered the vocabulary. He did, but I knew that ... that he'd been there and he had learnt about digital time.

[00:20:51.15] Interviewer: So you chose to ask a child to explain instead of explaining again yourself. Can you just talk me through why you chose a child and not to explain it yourself?

[00:21:03.08] Teacher: ermm just I think to show the children that You know... other children know it, and You know... it's not something only grownups need to know. I think that sometimes they just switch off if you just going on all the time (she laughs).

[00:21:19.08] Interviewer: You think that if they listen to one person, perhaps is that what you mean?

[00:21:26.02] Teacher: Yeah if it's all about explanation, rather than asking questions You know... 'cus if I just sat there and explained... for the whole lesson I don't think that they would engage. If I just talked (laughs again at the thought).

**PRELIMINARY THOUGHT: Question about the use of such a range of resources - clock faces. Some are plastic, some old cardboard.**

[00:22:35.29] Teacher: I think the ones we have work ok. The old cardboard ones, the hands slip sometimes. but it's ok if they're doing it on the flat. But when you tell them to show you, they slip. The plastic ones are too small I think, the faces are too small I think. I have since got some new ones, 'cus (she laughs) 'cus we don't actually have a complete set of either... so we've got some of the plastic and some of the cardboard ones. so I've just got some actually so, and they're ermm... they are cardboard but they are sort of laminated shiny. ermm... and they've got the erm... analogue clock, which is about the cardboard size, which is a good size but they have also got space for the digital time at the bottom, and you can write and wipe, with those ones. So...

[00:23:23.27] Interviewer: And they are both free hands or geared?

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|---|--|--|--|
|   |  |  | <p>[00:23:27.24] Teacher: No free hands.</p> <p>[00:23:36.01] Teacher: ermm... the geared... It's hard... because you do sort of have to I do think they have to know that the hour hand is moving, and I think that with the geared clock it can be easy to just take it for granted, because it just happens. ermm... but then it is really really hard for them especially once they get to, You know... you've done quarter past and quarter to, and you do your 5mins, and everything is going really great. And then as soon as you get to 1 minute time that's when the hands start going the wrong way, and that's why they get mixed up. and it's because it's almost as if there's too much going on. So in those situations, geared clocks are think are useful, but they are very expensive (laughs). I could have the small ones I did look into those,</p>   |
| Some are in digital and some in analogue. |  | <p>13:05 T stopped the class asking the ch. to put down their resources.</p> <p>T said she noticed how some children have finished and others had not – probably as they got blocked.</p> <p>T asks that 'We haven't talked much about how the times on the board are written differently, why are they written differently?'</p> <p>Different ways of writing time, can anyone explain why that is?</p> <p>Can you give me a digital?</p> | <p>00:26:14.21] Teacher: The ermm... day before. I had a bigger group playing a loop game on the carpet, and those were the three children who didn't quite achieve what I intended the quarter past and quarter to, and I just felt that they needed another lesson bout with the same objective, and more support in a smaller group.</p> <p>[00:26:41.24] Interviewer: and the next group was with another TA. Mrs Hodson's 17:25mins [WATCHED VIDEO]. So you did exactly the same with this group. You talked to the group, and asked them what did you do, what were you learning. SO is that something you would always do with your groups?</p> <p>[00:28:10.20] Teacher: Not if they're, not if it's the first lesson. ermm... usually I do. Or I ask the TA to.</p> <p>[00:28:29.09] Teacher: Same reason really. And I want them to know that they need to know. I'm not going to, if I sit there and tell them every time and then they're never going to be able to say what they're learning to do. So if they know it's coming.</p> <p>[00:28:50.01] Teacher: I just think that if you say it everyday, you are learning to do this and the next day you are saying you are learning to do this... I just don't think they are necessarily going to take it in, because they don't need to. Because nobody is asking them what they're learning.</p> |

|   |  |   |   |
|---|--|---|---|
| 11:23<br><br>Differentiated groups are called to go and work with different adults. | <p>Digital and analogue different ways of telling time.</p> <p>Learning to read quarter past/to the hour</p> <p>Telling the time nearest 5mins</p> | <p>An analogue?</p> <p>Quarter past 11.</p> <p>T repeats which is digital and analogue.</p> <p>She sends a small group off to work with a TA. She asked them what they were doing?</p> <p>Learning to tell the time when it is quarter past. Half past. O'clock, quarter to.</p> <p>Next group is called – she tells them they are going with another adult in the class. They will be working on reminds them of what they were doing – telling the time to the nearest 5 mins.</p> <p>Asks the next group called – what were you doing? Telling</p> | <p>[00:29:01.25] Interviewer: And why do you think that that's important?</p> <p>[00:29:04.12] Teacher: I think it's important for them to know what they are doing and why. You know... It gives it a purpose really. It makes them erm... it's hard to explain.</p> <p>[00:29:25.19] Interviewer: That's alright, it was a deep question...</p> <p>[00:29:25.19] Teacher: Yeah erm... I think it's just making them responsible for what they are doing. and if they don't know what they are learning, they just think of the activity and they do the activity and they go to lunch and the next day You know... it's gone. But whereas here they are thinking well if I do this today, tomorrow I can do this. Oh and yesterday I could do that. And it's you know, they can see at the end of a unit, what have, what can you do now that you couldn't do before? SO they can see... their achievement. I suppose.</p> <p><b>PRELIMINARY THOUGHT:</b> This collaborates with DAJ's idea and CSS about we're not just learning about cake!</p> <p>[00:33:29.16] Teacher: Yeah and a group I wanted to work independently. So I wanted them to be really clear about what I they were doing. Because erm... that's often why with the independent group I or independent groups, are often working on the same objective as the previous lesson, but consolidating that through a game or activity. Because I need them to be impendent. And if they get themselves stuck on things, then they're not going to be independent.</p> <p>[00:34:05.08] Teacher: The group that I'm left with erm... I can focus on then, And I tend to stick with them for the rest of the lesson, including each group including the ones that are being supported, to make notes once my group are getting on with the task, but then I would go back to them as well, as I would see them as my sort of... focussed group for that lesson.</p> <p>[00:34:32.28] Interviewer: So do you feel you have to sort of... when you are</p> |
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|  | Telling the time to nearest minute plus digital AM/PM. | <p>time to nearest 1 min. And the difference between digital and analogue. This today they are going to be working independently on those things again today. She shows them a new slide on the board – digital time AM and PM and asks what do they notice? Reminding them through questioning – what they were learning about and what times are showing on the board.</p> | <p>devising your groups and the activities for them, so the independent group you think differently about?</p> <p>[00:34:40.13] Teacher: Yeah I do definitely I do yeah.</p> <p>[00:34:42.23] Teacher: ermm... They have to be given something they can do. That I'm confident that they can do, so introducing a new concept is not really an option. At that point. That's why I often get them to just do the same objective, but it will be a different activity. SO the day before they did it with support. And this day they're doing it on their own. So yeah.. You know... there still is that chance that they'll not be able to do it, but from talking to the TA the previous lesson, those children that are in that group still are the one that she has said 'yeah they're doing well with this, they're nearly there with it.'</p> <p>[00:35:28.22] Interviewer: Thank you yes. I pushed you on this one a bit...</p> <p>[00:35:44.13] Teacher: Oh when he said oh Adam, said about to the nearest minute..</p> |
| Adam states that he thought some were really easy to read. |  | <p>T explains that the group he is in (she calls their names) that they are going to continue the game they played at the beginning of the lesson but with a new grid – the one on</p>   | <p>[00:36:27.00] Teacher: ermm... I think I suppose what he'd spotted... was,, I think he must of spotted something like 9 O'Clock or something, and ermm... it didn't worry me, it didn't matter at all. ermm... but the focus was onto the nearest minute. So he was being You know... really good. sort of... saying well if it's to the nearest minute why have you '00' or '15' or '30' because he was making that connection in that he'd done that before, You know... ermm... but I didn't think it was necessarily something that we'd need to get into. SO yeah he picked up something. which was really good.</p>  |

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| <p>Children appeared to be excited that they were going to continue to play the game.</p> |  | <p>the board.<br/>Teacher explains the equipment they need and sends the group off to play their game.</p>   |  |
|   |  | <p>The remaining group T asks if they felt confident that they could do the times shown on the board for the group that just left the carpet? If not they were to say now.</p> <p>She then went on to explain that the group were going to move on now to look at time differences.</p> <p>Explaining that given a start time and end time – how much time in between.</p> <p>Explains that they will need to sit at a computer or laptop, then log-on into Mathletics. They then need to gather</p> | <p>00:37:13.07] Interviewer: Lovely thank you very much. And then right... time differences... and you are using the matheletics game. can you talk to me a little bit about what that program is. Is it something specific for the school or?</p> <p>[00:37:33.03] Teacher: Yeah you buy into it. ermm... and we bought into it for the whole school. I think it's about £9 a child and it's something that's an internet game, so it's something they can go into on at home. There's two elements to it, there's ermm... speed mental maths, where they play against children from all over the world. It came from world maths day, which is what they do then. and the other element is the course, where you put the child in a particular year group, and ermm... there are activities for sort of... different elements of maths. and they can also choose to do something easier, or harder. So what I was doing with those children was, time differences. Which was... I know what my objective was and it so happened that I looked on mathletics and they had something. Because i know they enjoy mathletics, so You know... it's just an exciting medium really. To sort of practice with.</p> <p>[00:38:42.24] Teacher: Yeah, it does ermm... is it hard with the computers because you do have the, I mean we do have laptops and we do get the laptops</p> |

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| Different children asked to respond to each question at each | Time differences. | <p>round to one of the computers.</p> <p>At the computer this large group gathered to look at Mathletics.</p> <p>T explained where on the program they will be working and demonstrates the working of the first example. The example is simple to do as a mental calculation, but the T demonstrates using an empty number line to work out the difference.</p> <p>After explanation she gathered any questions the</p> | <p>shut down. And my laptop the battery is flat, and with mathletics, it does freeze from time to time, and it's hard when they are on question 3 and it freezes and then they after start all over again. Although they different questions, You know... they have still got to question 3 and so it's not ideal, but I do think it's better than giving them 10 questions on a sheet, here you go get on with those. Because they earn credits and the account that they're on it's just a little bit of incentive really.</p> <p><b>PRELIMINARY THOUGHT:</b> Is this crashing freezing out computer game better than a sheet of questions?</p> <p>[00:41:44.04] Teacher: ermm... because I don't, I don't mind how they do it, and I heard just Benjamin say that he would do it like that, and that's great, but I know that they are not all that easy (questions) and they might not be able to do all of them so, I'm showing them a method that works ermm... for them to sort of fall back on, because they will all try to do it in their head. Which is great. But if it doesn't work then they'll need another method. So that was what I was giving them.</p> <p>[00:42:20.11] Interviewer: Great thanks very much... and the method was....?</p> <p>[00:42:21.00] Teacher: Blank number line.</p> <p>[00:42:23.20] Interviewer: Is that something you use a lot?</p> <p>[00:42:25.01] Teacher: Yeah. All the time yeah.</p> <p>[00:42:25.01] Interviewer: Why?</p> <p>[00:42:29.19] Teacher: Well I think it's really visual, and it makes sense. You can really see exactly what's happening. And it's actually how you think it through in your head, so it's sort of... although you would use it when the question was a little bit too difficult to do in your head. It's the same sort of thinking, you are adding on an hour, you're adding on another hour and how many minutes are in between, what's the difference. So it's that thinking from your head. But it's</p> |
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| stage of the calculation.  |                                     | children in the group had and answered them.   | just giving you somewhere to record the steps so you don't forget I think.<br><br>[00:44:16.26] Teacher: I said that, I do this quite a lot, I think I just, I want it, I think the one thing I say all the time is... can you give that to me in another way. can you give me another word for that?<br>and it's just sort of... interchanging, the different things really and just making the connections all the time between the 60 minutes and the hour. And not forgetting that. Because sometimes... you are going to have to do it in minutes at some point... (laugh).   |
| Children respond to the Ts question<br><br>One child responds (after being picked)<br>We have been learning about time.<br><br>Quarter past/to<br><br>Nearest 5 mins.<br><br>Nearest 1 min.<br><br>Time differences. | Recap learning today in each group. | Teacher stops the class and asks them to look 'this way'.<br><br>Asks the class 'what have we all been learning about today?'<br><br>T then selects different children to explain what they have learnt about in their individual group. | Right you asked all the children the whole class, what they had been learning today, and ermm... now you have got the learning objective on the board, now are you expecting them to... is that a habit that you stand over in the middle of the room (not near the board).<br><br>[00:46:10.27] Teacher: Yeah at the end...<br><br>[00:46:11.09] Interviewer: why do you do that?<br><br>[00:46:13.06] Teacher: I just think it's I don't know why! ermm... You can see everybody, but there's I mean if I stood here gesturing to where we were sitting in the room, some of these children are quite far away. (It's an L shaped room really. Long and thin). So I would have to shout. I think I just stand here because if I yeah.... It just feels that everybody... it's the closest I feel I can get to everyone just there.<br><br>[00:46:46.07] Teacher: Ohhh, well they can if they want to. I mean if someone stood up to have a look I wouldn't say sit down what are you doing. You know... that would be fine, but I kind of would expect them to remember 'cus we talked about it at the beginning.<br><br>[00:47:02.16] Interviewer: And then you asked one child from each group, now is that ermm... is that planned for, is it that you wanted to get someone from each group, did you pick particular children from each group for example?<br>[00:47:15.08] Teacher: ermm...I picked... I usually pick the ones perhaps that |

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|  |  |   | <p>aren't so sure at the beginning. So like Bradley, and Charlotte at the beginning, he didn't put his hand up, so I wanted to just be sure that, You know... ok you didn't know it at the beginning, but you know now don't you so that's great. that's why. And if I can't if there is nobody that stands out like that then I will just be quite random about it really.</p>   |
|  |  | <p>Teacher then explains to the children that they now need to think about what they are going to be doing next. She emphasises that she expects them to think about what it is they will be doing in the next lesson about time.</p> <p>Pack up.</p> | <p>[00:47:43.08] Interviewer: And then you asked what's coming next....Or did you say what's coming next [WATCHED VIDEO] Ah yes, so can you just talk me through, because you alluded to that earlier?</p> <p>[00:48:04.23] Teacher: Yes as well as the children sort of clarifying in their own minds what they have been learning. I do that at the end so that the other children can see what their next step is, in that lesson. They can see that oh yeah that group over there have been doing 5mins I'll probably be doing that next lesson. Now it doesn't really matter to me if they can't work it out exactly. Especially the more able they don't know what's coming next for them unless I'm working with them and I tell them. ermm... It's just that knowing where they're going with it really.</p> <p>[00:48:46.29] Interviewer: So obviously this is one in a sequence of lessons, ermm... were you happy with where they ended up. (YEAH) the majority of the class, did they all move on, did you feel that they had.</p> <p>[00:49:01.19] Teacher: I did pick up that the children who were doing the time differences, ermm... they did that independently, in the next lesson. ermm... that they these children here who were independently working here, and I had been round so they moved onto time differences as well, so they ended up just a bigger group really. ermm...</p> <p>[00:49:25.01] Interviewer: You had more laptops and...</p> <p>[00:49:25.01] Teacher: yeah and I think there was six of those, so we had a much bigger group. But the ones that had already started went off and got on with it. And the others had the explanation about the numberline and that kind</p> |

of thing. I think there was a few if I remember rightly, that I noted down weren't using the numberline correctly or were relying too much on their head and not getting them correct, so they sort of stayed with this group and had the explanation again.

00:50:00.28] Teacher: I think I asked them, erm... but I do usually ask is there anybody who wants to or thinks they want to. And they are very good at doing that and being honest. i just have to watch because with some children if they are not very confident who always say I think i need to listen again. and so sometimes I just ignore them. Not ignore the request but think well actually I know best at this point, and I saw what you did yesterday and you need to be a bit braver and just have a go on your own now. And you know who those children are now anyway.

END

## Appendix 5.2

### Lesson analysis Example: ELLIE SRI response matched to observation Level 3

| Categories   |   |   | What mathematics were they doing?   | Summary of 3 lessons   |
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| Math Focus   | Pedagogical approach/strategies used  | Classroom Norms Behaviour emphasised                              | Lesson 1  | Teacher's conceptions<br>Lesson 1<br>Lesson 2<br>Lesson 3: Not observed.   |
| Focus on Knowledge of Shape properties and use of vocabulary | Game used to develop mathematical thinking and use of vocabulary.<br><br>Develop knowledge and understanding and mathematical thinking<br><br>Talking partners used extensively<br><br>T models the game and uses it to emphasise mathematical thinking explicitly. | Expectation of talk partners to challenge and support each other. | 2-D shape dictionary is displayed on the board:<br><br>Polygon<br>Corner<br>Quadrilateral<br>Right angle<br>Side<br>Vertex/vertices<br><br>T encourages the | [00:01:35.06] Teacher: The children and I had come up with that dictionary over the previous lessons, ermm... and they was the sort of... key words really for the unit on shape. And I was hoping they would use those words in the activity.<br><br>[00:03:44.12] Teacher: ok I just chose a random child, he actually the child sitting closest to me (RIGHT) that's probably why I chose him.... and I wanted to <b>model</b> the game for the children. As well as hopefully the children didn't have difficulty understanding how to play the game... I wanted to demonstrate the kind of vocabulary that I was hoping they would use in the activity as well.<br><br>What do you mean by modelling the game?<br>[00:04:24.25] Teacher:... you're <b>showing</b> a good example of playing the game, how to play the game successfully.<br><br>[00:04:51.14] Teacher: Yeah, yes so I suppose modelling would be really <b>modelling</b> how to play the game and modelling how to play the game well. Using the vocabulary.<br>She asked is modelling and demonstrate the same thing? YES<br><b>PRELIMINARY THOUGHT:</b> ECF believes that demonstrating and modelling are the same thing. |

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|  | Demonstrates the use of vocabulary through modelling the game.<br><br>Although she says she could have done this better – the point is that she offered this game and modelled it. She =e admits that her ideas are not always thought through extensively. (MAYBE she has good ideas) She had done this sort of thing before with her previous class. | Builds confidence in knowledge and use of mathematical vocabulary through TALK | children to think about the properties of shape. | [00:07:30.16] Teacher: ermm... I...I realised that it would have been better the other way round. It would have been better if he had... if he'd thought of the shape and I'd of asked the questions, then I would've used the different vocabulary. And I was also a little concerned that perhaps he wasn't going to get there. And I wanted him to, in front of the class to be successful, I didn't want him not to, not to be able to get there so... so I suppose I thought I should have done this a little bit differently, and actually I repeated this a week after. And I did it the other way round. SO you know, I was definitely thinking that because it... when I planned it for the next time I thought 'ooh I'm going to do it this way round this time'. But it put me under the spot light more, rather than poor George.(Both laugh together) But he seemed fine. (OH YES). He was enjoying it.<br><br>[00:08:29.04] Teacher: Well I didn't really think about it in too much... to be honest. ermm... If I'm completely honest with you... ermm...I knew that I wanted to that I wanted to model the game with a child, but <b>hadn't</b> through exactly how I was..<br><br>[00:09:25.19] Teacher: I've played that game ermm... with the year four children the previous year and they, but they haven't but they as a class haven't played that game as such... before.<br><br>[00:10:01.00] Teacher: It was really using the vocabulary. Yeah. That was the focus. And feeling confident to use the words but just with another person so it wasn't sort with everybody watching... Poor George (laughs). |
|  | Builds confidence in children using language effectively – try it out.   |  |  | [00:11:09.19] Teacher: Really as ... as encouraging to use the vocabulary and questioning as well so maybe... putting... using my own questions to help them to use that vocabulary.<br><br>[00:11:48.15] Teacher: Yes they make it really hard for each other as well. Which is.. <i>They want to be challenging don't they!</i>   |

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| Teacher questions the children about their vocabulary | Although the properties were not discussed, the use of the vocabulary was and the TYPE of question used. | T announced that there was some Confusion of vertex and vertices. She was often seen to emphasise and address any misunderstanding or misconception the children has been seen to struggle with or had asked her to explain. | Vocabulary and questions that asked about the properties of number. Properties were not explicitly talked named as properties but the questions and words were. | [00:15:06.11] Teacher: I think I was pleased because some of the words you know... there is no expectation that they have to know the word polygon... or you know even vertex and vertices. I think... I think it's still ok if they still call them corners, they do and... I think that, it was just that someone had asked... about a vertex and vertices, and because someone had been confused by the word polygon... you know, it was just an opportunity if you would like to know this is what it means.<br><br>PRELIMINARY THOUGHT: This is an interesting comment by ECF. The word Polygon is introduced in year 4 and vertex and vertices are introduced in year 3 according to the NNS vocabulary guidelines. ECF is stating that there is NO expectation that her class of year 3 and year 4s should know these words. This whole sequence contradicts her initial question to the class about their dictionary as all these words were on it, and she asked the class if they knew and understood these three words at the beginning of the session. These are children at a very affluent small village school. One would expect these children to be using words beyond their 'expectation' as they were indeed very able and very keen to develop their understanding given the right opportunities.<br>She may not hold a correct knowledge of content SCK – but does it anyway because she believes it is good. |
|   | Developed use of game later the following week.  |  |   | <i>Reflection on the activity - [00:16:15.17]</i> Teacher: I think I was fairly pleased for the first go ermm... at that kind of activity, there was definitely the vocabulary was being used. Perhaps not as widely as it could have been if they had had more practice at that kind of game. certainly when I did it the week after they were even better at using the vocabulary.<br>[00:16:33.21] Teacher: Yeah... and the excitement of that kind of game the first time they were very excited at playing a game... that was different.<br><br>PRELIMINARY THOUGHT: If ECF had a mixed year group surely half of them  |

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|  |  |  |   | would have played this game before? Need to check up on this with ECF. |
|  | <p><i>Children talk to their talk partner.</i></p> <p><i>Children discussed what they could see.</i></p> <p><i>One child asked the teacher what a particular shape was called.</i></p> <p>She <b>asks</b> if: Which different shapes you can see in the pattern?</p> | <p>Recognise 2-D shapes and name them in patterns.</p> <p>She made sure all had partners, then asked if anyone had any questions? No response. She says she will give them a minute to discuss this.</p> | <p>[00:18:17.27] Teacher: I wanted them to talk about what they could see in the pictures. ermm... and give everybody an opportunity to think about it, I think if I had just said right think about it and put your hands up, then some children would have really, you know really looked and some children perhaps would have not looked at all. So working with a partner and saying to them I'm going to choose a pair to talk about it. Enables them to actually do what you have asked them to do... and I don't have many problems with them not being on task, but you know... some children will try to take the easy route if they can. ermm... I chose two ermm... because I wanted the irregular... Because I mean success criteria, for one group was looking at irregular and regular, so I wanted the irregular to come out as well as the regular. ermm... but actually after discussion when we first discussed the one of the left, what i hadn't spotted actually when I looked at it.. was that there were many irregular shapes in the first one. And I probability didn't need the second one at all.</p> <p>Preliminary thought: Ellie said she wasn't aware of all the shapes that the children noticed – serendipity or intuition in choice of pattern?</p> <p>[00:20:15.29] Teacher: Yeah... the children have a talk partner for about 3 weeks, and they sit next to them on the carpet and they talk with that person in all lessons, all areas. And I just find that like I said really, that it gives everybody the opportunity to talk, rather than just those that want to talk in front of the class, and those that have their hands up all the time. And also I think with something like this. They are obviously mixed ability 'cus they're the same ones but you know there was so much that you could get from that whatever your ability really. 'cus it's like you said, like there's squares and there's triangles, but then there's also you know, irregular pentagons...</p> |  |

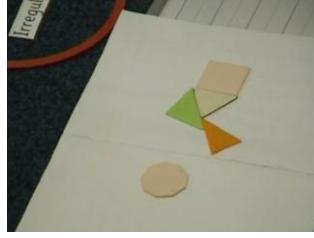
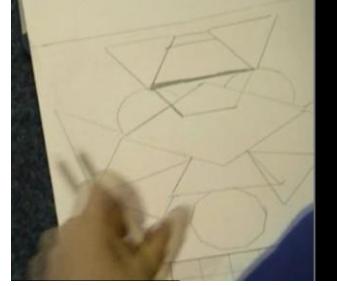
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| <p>Children name shapes but she asks the WC can anyone tell me anything about those shapes? E.g. asks child who names 'polygon' to define what a polygon is.</p> <p>Now what is a regular polygon (the extra information we are learning today).</p> <p>She asked Benjamin to tell them what else he saw. He was invited to the board to show – his dodecagon is. And explains to the class how she thought he was describing what they had looked at before the</p> | <p>She asks them to come up and show the class where they saw the squares, triangles and hexagons.</p> | <p>Children put hands up as keen to tell her what they have spotted. She tells them to put them down and asks different children what they have seen.</p> <p>She stops the class and asks different children what shapes they saw. She insisted on NO hands!</p> | <p>Children name the shapes AND define properties.</p> | <p>00:21:35.01] Teacher: yeah, I mean I didn't mind that there was... I didn't mind that there was lots of discussion I think that was good. And I think you know... sometimes when we get observed we get too worried about sticking to the timings and... right we've got to move on and... I don't think it matters at all... I think if there was anybody at all was fidgety or.. most of the children were engaged and they were interested. I probably just would have, just would have chosen the one on the left because there was so much just in that one picture anyway, and we didn't really need that other one anyway. And I suppose my thoughts afterwards was that I could of... continued with that in the main part of the lesson with the group that were working on the regular and irregular. Because obviously they had more to say, and that's why I said at the end, if you've got something else to say... (Laughs remembering just how children wanted to add to the discussion) then put it on a post-it note and then after, I think it was after break or after you had gone actually... that we did sit down and we did ripped the post-it notes off and talked about who... what everyone else wanted to say. So I think it's important that if they have got something to say, they found something then you don't just dismiss it and say right, we're moving on now and....</p> <p><b>PRELIMINARY THOUGHT:</b> Interesting reflection here by ECF, this is in stark contrast to both CSS and DAJ who felt restricted by time and talked much about moving onto the next thing when they wanted to stay with a discussion/item/activity.</p> |
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| <p>dodecahedron when they were looking at 3-D shapes, but he checked it in the dictionary and found the correct word.</p> <p>Children start to ID shape parts (sliced edges of pattern) Ben says he can see a trapezium and is asked to show the class.</p> <p>The children are now looking more at the 'cut' shapes at the edge of the tessellation picture and working out what the shape is.</p> | <p>The children are now seeing more shapes than they had with their partner as a consequence of a child spotting the cut shape at the edge of the picture</p> <p>she thought he was describing what they had looked at before the dodecahedron when they were looking at 3-D shapes, but he checked it in the dictionary and found the correct word.</p> <p>She asks another child what he had seen.</p> <p>Praises him for seeing the Half a hexagon and asks if it is now a</p> |  |  | <p>[00:22:57.05] Teacher: Erm... I have used pictures before erm... but actually I was just looking for something regular and irregular, and I was just searching the internet. And then it came to me, tessellations came to mind, and then actually I used I did a similar thing when I did a plenary in 3-D shape, I found something on the internet where somebody had made a rocket out of polydron and I put that on the board and said to them 'now what 3-D shape can you find.. you know what kind of 3-D shapes can you find' and it worked just as well. But I like, I like it because it's really open ended. And they seem really keen to find really tricky shapes and... (Laughs)</p> |
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|   | <p>new shape?</p> <p>T expands on the idea of quadrilateral and regular pentagons. She asks questions and encourages individuals to speak up. Lewis states it must be an irregular pentagon and explains why when encouraged further. Gives them a clue how Lewis was 'counting'.</p> <p>T encourages more ideas from the class.</p> | <p>had with their partner as a consequence of a child spotting the cut shape at the edge of the picture.</p> <p>Regular<br/>Irregular<br/>Truncated shapes</p> | <p>[00:26:05.02] Teacher: I think it was something that came into my mind at that point. I had remembered that somebody had been confused pentagons and hexagons, and I suppose, it was just a sort of an aide really to just to clarify... probably should have said what a pentagon was as well. (Laughs)</p> <p>[00:27:09.08] Teacher: ermm... no, and there probably are children who still get them confused, but I just don't know whether it's that important that they you know... 'cus that's just rote learning really isn't it! And I just think (IT'S GREEK!) Yeah.. I know and I just think well, I said it because I know some children were confused and hopefully there will be some children sitting there that would have got it, and maybe even just for that lesson. Maybe not forever, but you know... eventually they will all know what a hexagon is. Just not right now necessarily. So I didn't say it because I thought 'right... everyone will understand now'.. I said it because I hoped that some would especially the ones that had got the confusion earlier.</p> <p>[00:30:17.24] Interviewer: Right because I've got the question the half hexagon discussion I was gonna ask if that was planned for or whether spontaneous, clearly after our last discussion it wasn't planned for..</p> <p>[00:30:28.08] Teacher: No it wasn't planned for no...</p> <p>[00:30:34.19] Interviewer: this sort of... thing comes up... (YEAH) so in your, clearly in you're pleased that these extra things have started now to come out, hadn't they. do you think that was instigated by Ben, because he started looking at these, on this side (pointing to the screen at the edges of the picture) didn't he... I can't remember which one it was now. Was sit this</p> |
| One child spots a triangle that has been cut. | T asks the class what the triangle is called when all the sides are a different length?  |  |   |
| Joshua says it is a truncated triangle.       | T asks her to come up and show them.   |  |   |
| One child says she can see a diamond.         | T asks the child what is the difference between a diamond and a square?  |  |   |

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| <p>One girl spots another pentagon and explains why she believes it is a pentagon.</p> | <p>They establish that the shape she saw was a square but orientated by 45'</p>   |  | <p>one? and he ermm... oh no you'd looked at this one hadn't you, (YEAP) and so do you think that evoked the others to look deeper, or do you think they already had those ideas? Do you think it sort of evolved as the discussion went on?</p> <p>[00:31:09.16] Teacher: Yeah I think they definite... I think there were things that came out in the discussion especially later in the discussion. That the children hadn't discussed with their partner, because as we talked, they looked more deeply I think. So yeah, I definitely think it evolved. And probably from I think there was some children that from hearing from what they were saying that when they had their discussion they were picking out the ones that weren't obvious. But then I think what Ben had said to the class, made others like Lewis, think, 'oh hang on then, I can look at other things' so yeah. Definitely...</p> <p>[00:32:21.05] Teacher: I wanted it to be... I wanted the children to be able to name some 2-D shapes. Everybody to name some 2-D shapes, and I wanted the more able to think about whether they were regular or irregular.</p> |
|  | <p>She asks the class what sort of pentagons they are. T laughs how the children are mixing their hexagon name with the pentagon today.</p> <p>T reiterates that the pentagons look squashed as though someone has sat on</p> | <p>DISCUSSION interactive between whole class and teacher. Some children are allowed to develop their knowledge at a higher level than others.</p> | <p>They look at the next pattern – tessellation of pentagons in two colours.</p> <p>[00:32:37.01] Interviewer: That was your goal?<br/> [00:32:37.15] Teacher: Yeah!<br/> [00:32:38.16] Interviewer: but you got lots more (both laugh together)<br/> [00:32:39.18] Teacher: Yes!<br/> [00:32:42.19] Interviewer: Which is great isn't it?<br/> [00:32:42.19] Teacher: And I think more than just the more able that were able to understand the regular, irregular from it as well, which was good. (YEAP).</p> <p>[00:35:51.05] Teacher: Last year... we've got these wooden shapes, and we'd got free, they are so random. I mean they're good shapes, there's like an egg in there, so that's how random they are ermm... and there's the cone with the top cut off and they were... and Adam and some of the other boys were</p>   |

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|  | <p>them.</p> <p>Ben sees another shape and comes up to show the class (very able boy) and says that the shape he has seen is an irregular square.</p> <p>T asks if he is sure they would be irregular squares? Asks another child who disagrees with the idea who says they are quadrilaterals. T asks Ben if he is happy with their definition and justification. He is and sits down even though he wants to show the class more shapes he has spotted.</p> <p>Questions individuals and class about their understanding of regular and irregular polygons.</p> |  | <p>saying 'well what's this?' and he looked it up... and then.. and because we've got the polydron as well, and a lot of the big polydron shapes are called truncated if they've got the corners cut off. So they just think that anything with a bit cut off can be called truncated. (Both laugh)</p> <p>[00:36:31.02] Interviewer: That's great, so this, on this can you just talk me through just a little bit, as here we've got quite a further extension. Instead of the children necessarily doing ermm... the sort of talking, you're actually pulling out here prior knowledge. Was this a conscious decision, because obviously a lot came out of this discussion from this picture, was it a conscious decision to take this further and check understanding, or was it just a sort of... explore where this could go further. Can you remember what you were thinking at the time?</p> <p>[00:37:16.05] Teacher: I think it's ermm...it's just an opportunity to talk and for children to... if they found out something interesting to be able to talk about it. And when I was asking Olivia ermm... she couldn't remember the whole definition, and the day before we had looked into it her and I using a dictionary, and I think it's just that opportunity that yeah, it was worth it. Because here it is we're talking about it now, and I suppose it's just that kind of thing. I think it's really just letting the children know that it's not just this is what we're doing today, it doesn't matter what we did before, it's well you've found out this really good stuff like the truncated cone. That was the year before.... ermm... it was ok to bring that up even though it's not quite right.</p> <p>[00:38:11.18] Interviewer: I was quite, I was really quite taken a back when that when little lad said that!</p> <p>[00:38:18.18] Teacher: Yeah and people.. and whenever people come in to see maths they do say that they children's vocabulary they just can't believe you know, with the things they come out with. But I think it's just because we talk, and we use the words and they are confident to be able to use them and get them wrong and mix them up and that kind of thing really.</p> |
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|  | <p>Places the children in groups reads a list out to tell them who will be working with her.</p> <p>Small group T-led will be working on quadrilaterals. They have to refer to their work from yesterday and work on any comments placed there by the T.</p> <p>Asks the two groups if they have any questions and sends them off to work with TA.</p> |  | <p>Quadrilaterals</p> <p>Sort shapes into regular /irregular shapes – extension to tessellate different shapes, what shapes tessellate?</p> | <br>  |
|  | <p>Main activity in differentiated groups. Groups alter daily as to their development in level.</p>  |  |   | <p>00:42:57.03] Teacher: Yeah they were erm... I was hoping they would be able to recognise different quadrilaterals erm... and actually they started, some of them had started before but perhaps had not got very far or perhaps they had made slight errors. So I kept them in that group. Some of them were completely new to it. erm... So the shapes, I put a range of shapes on the table not just quadrilaterals, erm... and the idea they would pick quadrilaterals and draw round them and name them if they could. and then the paper was because some of them had started it before erm... but not got as far as... you know only done one or two... erm... that was sort of... an open ended extension task with the tangrams to use the paper</p> |

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|  |  |  |  | <p>shapes to see if they could make any quadrilaterals. Using those paper shapes.</p> <p>[00:43:57.02] Interviewer: Did you have a.... then you had these children working on.... you had these sheets here - pointing to the clip. With these words here. Is that a word bank or?</p> <p>[00:44:15.07] Teacher: Yeah because I do ermm... sort of do a progression of the success criteria, I'd had groups earlier in the week that had done the activity and they nice thing about teaching like that, when things don't go quite right you can rectify then straight away with the next group. And what they were struggling with was spelling and worrying about it. It didn't matter to me whether they spelt them right or wrong... but if they worry about.. they want to spell them right, and the other thing with some of the shapes that they were choosing they were really interested in them. But there was no way they would have known a parallelogram, they would probably never had known that word before at all. So what it enabled for them to do was to eliminate them. So there was two reasons really one they could eliminate them to get the name what the name was, and to if they was really desperate to spell it correctly then it was there for them to copy.</p> |
|  |  |  |  | <p>[00:45:37.12] Interviewer: and these two, they were really interested weren't they. They were fab! Then they didn't want to go out to play then they took it out to play with them. (Laugh) I was trying to get this shot on tessellating. ermm... What are the difficulties when you are ermm... you obviously want to see what can they do with tessellating, and you've got some resources there... what are the difficulties in teaching ermm... this particular area of geometry?</p> <p>[00:46:15.18] Teacher: I think that they it's hard to test them when you drawing round them, because you make a mistake and then that's it then,,, you've got to start again. Which is the problem. So to have some way of testing them without them having to draw.</p>  |

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|  |  |  |  | <p>[00:46:30.28] Interviewer: And what about the resources you have?</p> <p>[00:46:35.17] Teacher: If you had more of each one, you could test them with the resources, without having to draw around them I think. And actually, he wanted to use lots of different shapes, and then next time. because we did another lesson on it 'cus they didn't have that much time really, and erm... the next lesson I challenged them right you've had a go with lots of different shapes, what can you do with just one or two shapes. SO they could really see... because obviously you know when they were tessellating with all these different shapes they weren't tessellating, you know they were just putting them all together. But then what I hoped, what I don't think it matters as long as they're talking about what they're doing.</p> <p>[00:47:16.13] Interviewer: And they certainly were engaged weren't they! they were doing lots of things, they were both coming out and talking about what they were doing. yeah. You had to stop the lesson because they were still going great guns... erm... so you obviously said you carried it on later so that's it. Thank you.</p> |
|  |  |  |  | <p>00:47:49.14] Interviewer: How did that feel that lesson in the end, because you voiced a couple of things that came up, Oh and the discussion went on longer, but we carried that over. How does that what sort of reflections... what do you think about when you are reflecting,,, or did you think about on this particular lesson? Were you satisfied?</p> <p>[00:48:15.02] Teacher: Yeah, I think, Yeah I was satisfied with the lesson. And I think they are always.. I don't think you are a very good teacher if you don't reflect on it. If you think that everything always goes well then you are not a very good teacher I think. It doesn't does it all the time! and erm... but I think the most important thing is to reflect on it and then just sort of... if you need to make the changes for next time or try things again and do it a little bit differently, erm... or just be happy that well ok the talk did go on for longer than I expected, because that's alright, I think that's alright</p>  |

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|            |  |                                      |                                   | <p>anyway, so just generally, I think the lesson was fine. I suppose there are things like when Benjamin said to me about the name of the shape and I said no and he went and proved me wrong, that kind of thing, and then you think well does that matter. You know he. Why would I know that?</p> <p>[00:49:12.26] Interviewer: from an observers point of view I could have taken it either way, oh she's getting him to look it up because she's pretending or it was as you say... although it's neither one way or another... ermm... and as you say it doesn't really matter. It's about the discussion. So we'll leave it there. Thank you very much.</p> <p>END</p>  |
| Math Focus | Pedagogical approach/strategies used   | Classroom Norms Behaviour emphasised | What mathematics were they doing? | <b>Lesson 2</b>  |
|            | <p>T used a timer in the IWB to get the children settled onto the carpet</p> <p>Teacher asks what they have been learning about.</p> <p>LO<br/><b>Learning all about time.</b></p> |                                      | <p>Time</p>                       | <p>[00:01:14.28] Teacher: Yes it's 2 minutes 15 and ermm... it's an interactive timer that I use to ermm... it's just actually a class management tool that I use. So that when they come in in the morning, ermm... I set the timer and it's visual, so they've got... it's counts down. ermm... and also there's music with it as well for well things they like, like Dr who and Indiana Jones and those kinds of things as well. So it's that sort of... you've got to be ready by... 2 mins 15.</p> <p><b>Out OF Sync:</b> 00:05:03.28] Teacher: Hmm when it's the first lesson I would normally write it up and we'd pull it all apart. Looking at all the words and what they mean and... and what exactly that is and then... from then on... because the learning objective will stay the same for a period of... a few lessons, maybe even a week, and because the context is taken out of it so... if it was... well... we can... we are learning to measure time. So it doesn't matter what they are doing, they are still learning to measure time so then the next successive lesson I would expect that the children would be able to</p> |

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| <p>Children on the carpet in front of the IWB.</p> <p><b>GAME</b></p> <p>They are instructed to have a small card clock. And two wb pens one of blue one of black. They also have a small WB between the pair.</p> <p>Teacher asks what can you see on the screen?</p> <p>Target board on screen with times on.</p> <p>Teacher gives instructions that one of the pair will draw out a grid with 5 columns and 5 rows. She demonstrates on a small white board.</p> <p>She points to the board on the screen which also has 5 rows</p> | <p>Recognise written times</p> | <p>tell me... (silence)?</p> <p>On a 5 x 5 grid with different times on ermm... and you asked that question...[WATCHED VIDEO] 'what can you see on the screen?' yes on the grid. yeah. So can you tell me why you asked that particular question? What can you see on the screen?</p> <p>[00:02:59.23] Teacher: Yeah I didn't want to lead them in any way. I just wanted them to tell me anything they could at all about... about what they could see really.</p> <p>[00:04:18.25] Teacher: Yeah, ermm... the learning objective was, is displayed always above my head. But I didn't say it straight away because some people, some of the children were able to remember anyway. And then when somebody did look in the right place just to get maybe a few more hands, a few more children thinking about it, that's why I asked.</p> |
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| <p>and 5 columns.</p> <p>Teacher plays the <b>game</b> with one child.</p> <p>Quarter past 7. Who can tell me where that might be displayed on our grid?</p> <p>Explains then she will make quarter past seven on the small clock, and she has to say if the time is right. Any questions?</p> | <p>Children ask a range of questions. One asks what if you get one wrong?</p> <p>Can we block? Child explains how he might block his partner.</p> | <p>Children have introduced a logical strategic decision on the game.</p> | <p>00:08:44.17] Teacher: It's... it's showing them how to do it. So modelling the game, rather than just telling them how to play the game, so they can see it in action, really, and they can see a child doing it so... if anyone is sitting there thinking 'I can't do this' then they can because Sophie could (laughs). So it's You know... them actually watching the game being played, which I always find... it just seems to work better otherwise, if you just explain, how to play something you just get a lots of children throughout the course of the activity 'I don't know what to do!'... 'we don't know what to do!'. and then they time's just wasted then really.</p> <p><b>PRELIMINARY THOUGHT:</b> Contradiction here with her idea of modelling and demonstration telling vs showing? An interesting thought that modelling a game is better than explaining a game!</p> <p>00:09:45.12] Teacher: they are erm... talk partners, so mixed ability pairs. they might have been different to last time as we change them every 2 -3 weeks. I think they were actually different to last time. erm... and so yeah... and that's another reason for having such a widely differentiated task, because it was the whole class and erm... they were in mixed ability pairs so they were both persons in the pairs have got to be able to access the task.</p> <p>[00:10:44.12] Teacher: Yeah well I know that they're generally a group that will engage for if they're interested in something, then they will engage. For 5 or ten minutes even. erm... I didn't want it to be ...as it was consolidation, I didn't want it to drag on, I wanted them to move on, in that lesson. So I thought 5 minutes was a good opportunity to get into the game but not for it to drag on and take too much of the rest of the lesson really.</p> <p>00:11:16.14] Interviewer: Because it wasn't just the fact they had to show</p> |
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|  |  |  |                                   | <p>each other and they make that decision, about... I mean how successful do you think is, that they are in mixed ability and one child is perhaps not as far on, not necessarily lower ability of course... but erm... how they are using time. If one child has done say erm... 11:23 and the other child was working on quarters, erm... how could,, I mean 'cus you could over hear things, how did you feel it all went?</p> <p>[00:11:54.02] Teacher: I think there is always the chance that You know... the less able child would just say yes that's fine... because they perhaps know that child is good at maths or is confident, erm... but I'm not sure that that really... really matters too much 'cus they're still both engaged in the game both of them are and the chances are the first child has got it right anyway, and unless they are playing the game and... the the ... lower ability child is accessing that within their group. They're not accessing. SO they get to see what that 11:23 looks like You know... from a different person not just from me.</p> |
|  |  |  | Discussion games with interviewer | <p>[00:12:55.25] Teacher: Yeah I think whenever.... I always tend to look for the game in things really. Because it's fun for them and they enjoy it more when they think it's a game so... I just thought... well I looked at it and thought 'ooh I could make this into a four in a row, five in a row in this case, with this one.'</p> <p>[00:14:18.00] Teacher: Yeah, but I 'cus I got twenty five I do have a partner. So usually I work with that person but then when they are doing something I have a wonder round. I mean I just, well it's normally erm... asking... it's sort of getting them to play the game correctly. SO that they are doing, they are achieving what I want them to achieve. So then if they are not checking each others, I will say 'ooh how do you know she is right or do how do you know he's right' and that kind of thing. So keeping them, keeping not on task because they are on task... nut keep them focussing on the task I want them to do really.</p>  |
|  |  |  |                                   | [00:17:03.00] Teacher: I think it was what I had been doing with Sophie. And  |

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|  |                     |       |  | <p>the conversation whilst playing the game sort of... Jack had said at the beginning they were different times... ermm... but we hadn't sort of... talked about the different format of the times.</p> <p>[00:17:28.24] Teacher: And some of the children had been learning about digital time, so they did know that. But there were some children that hadn't got that far, so it probably would have best it had come at the beginning, but because I hadn't thought of it then, I thought I'd ask it then.</p> <p>[00:17:57.29] Teacher: I wanted some of the children to realise that there were digital times and what they looked like. And that there are analogue times, and what they looked like.</p> <p><b>PRELIMINARY THOUGHT:</b> Interesting that ECF assumes that all children do not or have not come across digital times outside the classroom??</p> <p>[00:18:18.06] Teacher: It's really hard. ermm... I have found that in the past that with the two it is really difficult. And so I always try to run it alongside, so when we move onto to say twenty to eight... we talk about that as 40 mins past seven first. and then... well I say to the children we can say that in a different way, how else... they can change them really.</p> <p>[00:18:58.17] Teacher: I think it should be there ermm... but I think that the focus is on analogue and the digital comes in at year four... ermm... whereas they are more used to the digital times before that, and so that it should probably be the other way round really...</p> |
|  | Cardboard resources | clock |  | <p>[00:19:22.07] Interviewer: Thank you. [WATCHED VIDEO] So you used Adam... did you chose Adam particularly because you knew he could answer?</p> <p>[00:20:32.14] Teacher: I knew he'd done the digital time, but I did not know if he necessarily be able to answer, he might have forgotten he might not</p>  |

have remembered the vocabulary. He did, but I knew that ... that he'd been there and he had learnt about digital time.

[00:20:51.15] Interviewer: So you chose to ask a child to explain instead of explaining again yourself. Can you just talk me through why you chose a child and not to explain it yourself?

[00:21:03.08] Teacher: ermm just I think to show the children that You know... other children know it, and You know... it's not something only grownups need to know. I think that sometimes they just switch off if you just going on all the time (she laughs).

[00:21:19.08] Interviewer: You think that if they listen to one person, perhaps is that what you mean?

[00:21:26.02] Teacher: Yeah if it's all about explanation, rather than asking questions You know... 'cus if I just sat there and explained... for the whole lesson I don't think that they would engage. If I just talked (laughs again at the thought).

**PRELIMINARY THOUGHT:** Question about the use of such a range of resources - clock faces. Some are plastic, some old cardboard.

[00:22:35.29] Teacher: I think the ones we have work ok. The old cardboard ones, the hands slip sometimes. but it's ok if they're doing it on the flat. But when you tell them to show you, they slip. The plastic ones are too small I think, the faces are too small I think. I have since got some new ones, 'cus (she laughs) 'cus we don't actually have a complete set of either... so we've got some of the plastic and some of the cardboard ones. so I've just got some actually so, and they're ermm... they are cardboard but they are sort of laminated shiny. ermm... and they've got the erm... analogue clock, which is about the cardboard size, which is a good size but they have also got space for the digital time at the bottom, and you can write and wipe, with those ones. So...

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|  |  |  |  | <p>[00:23:23.27] Interviewer: And they are both free hands or geared?</p> <p>[00:23:27.24] Teacher: No free hands.</p> <p>[00:23:36.01] Teacher: ermm... the geared... It's hard... because you do sort of have to I do think they have to know that the hour hand is moving, and I think that with the geared clock it can be easy to just take it for granted, because it just happens. ermm... but then it is really really hard for them especially once they get to, You know... you've done quarter past and quarter to, and you do your 5mins, and everything is going really great. And then as soon as you get to 1 minute time that's when the hands start going the wrong way, and that's why they get mixed up. and it's because it's almost as if there's too much going on. So in those situations, geared clocks are think are useful, but they are very expensive (laughs). I could have the small ones I did look into those,</p>  |
| 13:05 T stopped the class asking the ch. to put down their resources.<br><br>T said she noticed how some children have finished and others had not – probably as they got blocked.<br><br>T asks that 'We haven't talked much about how the times on the |  |  |  | <p>00:26:14.21] Teacher: The ermm... day before. I had a bigger group playing a loop game on the carpet, and those were the three children who didn't quite achieve what I intended the quarter past and quarter to, and I just felt that they needed another lesson bout with the same objective, and more support in a smaller group.</p> <p>[00:26:41.24] Interviewer: and the next group was with another TA. Mrs Hodson's 17:25mins [WATCHED VIDEO]. So you did exactly the same with this group. You talked to the group, and asked them what did you do, what were you learning. SO is that something you would always do with your groups?</p> <p>[00:28:10.20] Teacher: Not if they're, not if it's the first lesson. ermm... usually I do. Or I ask the TA to.</p> <p>[00:28:29.09] Teacher: Same reason really. And I want them to know that they need to know. I'm not going to, if I sit there and tell them every time and then they're never going to be able to say what they're learning to do. So if they know it's coming.</p> <p>[00:28:50.01] Teacher: I just think that if you say it everyday, you are</p> |

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| <p>board are written differently, why are they written differently?'</p> <p>Different ways of writing time, can anyone explain why that is?</p> <p>Can you give me a digital?</p> |  |  |  | <p>learning to do this and the next day you are saying you are learning to do this... I just don't think they are necessarily going to take it in, because they don't need to. Because nobody is asking them what they're learning.</p> <p>[00:29:01.25] Interviewer: And why do you think that that's important?</p> <p>[00:29:04.12] Teacher: I think it's important for them to know what they are doing and why. You know... It gives it a purpose really. It makes them ermm... it's hard to explain.</p> <p>[00:29:25.19] Interviewer: That's alright, it was a deep question...</p> <p>[00:29:25.19] Teacher: Yeah ermmm.... I think it's just making them responsible for what they are doing. and if they don't know what they are learning, they just think of the activity and they do the activity and they go to lunch and the next day You know... it's gone. But whereas here they are thinking well if I do this today, tomorrow I can do this. Oh and yesterday I could do that. And it's you know, they can see at the end of a unit, what have, what can you do now that you couldn't do before? SO they can see... their achievement. I suppose.</p> <p><b>PRELIMINARY THOUGHT:</b> This collaborates with DAJ's idea and CSS about we're not just learning about cake!</p> <p>[00:33:29.16] Teacher: Yeah and a group I wanted to work independently. So I wanted them to be really clear about what they were doing. Because ermm... that's often why with the independent group I or independent groups, are often working on the same objective as the previous lesson, but consolidating that through a game or activity. Because I need them to be impendent. And if they get themselves stuck on things, then they're not going to be independent.</p> <p>[00:34:05.08] Teacher: The group that I'm left with ermm... I can focus on then, And I tend to stick with them for the rest of the lesson, including each</p> |
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|                |                     |                   |             | <p>group including the ones that are being supported, to make notes once my group are getting on with the task, but then I would go back to them as well, as I would see them as my sort of... focussed group for that lesson.</p> <p>[00:34:32.28] Interviewer: So do you feel you have to sort of... when you are devising your groups and the activities for them, so the independent group you think differently about?</p> <p>[00:34:40.13] Teacher: Yeah I do definitely I do yeah.</p> <p>[00:34:42.23] Teacher: ermm... They have to be given something they can do. That I'm confident that they can do, so introducing a new concept is not really an option. At that point. That's why I often get them to just do the same objective, but it will be a different activity. SO the day before they did it with support. And this day they're doing it on their own. So yeah.. You know... there still is that chance that they'll not be able to do it, but from talking to the TA the previous lesson, those children that are in that group still are the one that she has said 'yeah they're doing well with this, they're nearly there with it.</p> <p>[00:35:28.22] Interviewer: Thank you yes. I pushed you on this one a bit...</p> <p>[00:35:44.13] Teacher: Oh when he said oh Adam, said about to the nearest minute.</p> <p>[00:36:27.00] Teacher: ermm... I think I suppose what he'd spotted... was,, I think he must of spotted something like 9 O'Clock or something, and ermm... it didn't worry me, it didn't matter at all. ermm... but the focus was onto the nearest minute. So he was being You know... really good. sort of... saying well if it's to the nearest minute why have you '00' or '15' or '30' because he was making that connection in that he'd done that before, You know... ermm... but I didn't think it was necessarily something that we'd need to get into. SO yeah he picked up something. which was really good.</p> |
| Differentiated | T explains that the | Children appeared | Digital and | [00:37:13.07] Interviewer: Lovely thank you very much. And then right... time   |

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| <p>groups are called to go and work with different adults.</p> | <p>group he is in (she calls their names) that they are going to continue the game they played at the beginning of the lesson but with a new grid – the one on the board.</p> <p>Teacher explains the equipment they need and sends the group off to play their game.</p> | <p>to be excited that they were going to continue to play the game.</p> | <p>analogue different ways of telling time.</p> <p>Learning to read quarter past/to the hour</p> <p>Telling the time nearest 5mins</p> <p>Telling the time to nearest minute plus digital AM/PM.</p> | <p>differences... and you are using the matheletics game. can you talk to me a little bit about what that program is. Is it something specific for the school or?</p> <p>[00:37:33.03] Teacher: Yeah you buy into it. ermm... and we bought into it for the whole school. I think it's about £9 a child and it's something that's an internet game, so it's something they can go into on at home. There's two elements to it, there's ermm... speed mental maths, where they play against children from all over the world. It came from world maths day, which is what they do then. and the other element is the course, where you put the child in a particular year group, and ermm... there are activities for sort of... different elements of maths. and they can also choose to do something easier, or harder. So what I was doing with those children was, time differences. Which was... I know what my objective was and it so happened that I looked on mathletics and they had something. Because i know they enjoy mathletics, so You know... it's just an exciting medium really. To sort of practice with.</p> <p>[00:38:42.24] Teacher: Yeah, it does ermm... is it hard with the computers because you do have the, I mean we do have laptops and we do get the laptops shut down. And my laptop the battery is flat, and with mathletics, it does freeze form time to time, and it's hard when they are on question 3 and it freezes and then they after start all over again. Although they different questions, You know... they have still got to question 3 and so it's not ideal, but I do think it's better than giving them 10 questions on a sheet, here you go get on with those. Because they earn credits and the account that they're on it's just a little bit of incentive really.</p> <p><b>PRELIMINARY THOUGHT:</b> Is this crashing freezing out computer game better than a sheet of questions?</p> <p>[00:41:44.04] Teacher: ermm... because I don't, I don't mind how they do it,</p> |
|--|---|---|--|--|

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  | <p>and I heard just Benjamin say that he would do it like that, and that's great, but I know that they are not all that easy (questions) and they might not be able to do all of them so, I'm showing them a method that works ermm... for them to sort of fall back on, because they will all try to do it in their head. Which is great. But if it doesn't work then they'll need another method. So that was what I was giving them.</p> <p>[00:42:20.11] Interviewer: Great thanks very much... and the method was....?</p> <p>[00:42:21.00] Teacher: Blank number line.</p> <p>[00:42:23.20] Interviewer: Is that something you use a lot?</p> <p>[00:42:25.01] Teacher: Yeah. All the time yeah.</p> <p>[00:42:25.01] Interviewer: Why?</p> <p>[00:42:29.19] Teacher: Well I think it's really visual, and it makes sense. You can really see exactly what's happening. And it's actually how you think it through in your head, so it's sort of... although you would use it when the question was a little bit too difficult to do in your head. It's the same sort of thinking, you are adding on an hour, you're adding on another hour and how many minutes are in between, what's the difference. So it's that thinking from your head. But it's just giving you somewhere to record the steps so you don't forget I think.</p> <p>[00:44:16.26] Teacher: I said that, I do this quite a lot, I think I just, I want it, I think the one thing I say all the time is... can you give that to me in another way. can you give me another word for that? and it's just sort of... interchanging, the different things really and just making the connections all the time between the 60 minutes and the hour. And not forgetting that. Because sometimes... you are going to have to do it in minutes at some point... (laugh).</p> |
|--|--|--|--|--|

|  |  |   |  |
|--|--|---|--|
|  |  | <p>Recap learning today in each group.</p> <p>Children respond to the Ts question</p> <p>One child responds (after being picked)<br/>We have been learning about time.</p> <p>Quarter past/to</p> <p>Nearest 5 mins.</p> <p>Nearest 1 min.</p> <p>Time differences.</p> | <p>Right you asked all the children the whole class, what they had been learning today, and ermm... now you have got the learning objective on the board, now are you expecting them to... is that a habit that you stand over in the middle of the room (not near the board).</p> <p>[00:46:10.27] Teacher: Yeah at the end...</p> <p>[00:46:11.09] Interviewer: why do you do that?</p> <p>[00:46:13.06] Teacher: I just think it's I don't know why! ermm... You can see everybody, but there's I mean if I stood here gesturing to where we were sitting in the room, some of these children are quite far away. (It's an L shaped room really. Long and thin). So I would have to shout. I think I just stand here because if I yeah.... It just feels that everybody... it's the closest I feel I can get to everyone just there.</p> <p>[00:46:46.07] Teacher: Ohhh, well they can if they want to. I mean if someone stood up to have a look I wouldn't say sit down what are you doing. You know... that would be fine, but I kind of would expect them to remember 'cus we talked about it at the beginning.</p> <p>[00:47:02.16] Interviewer: And then you asked one child from each group, now is that ermm... is that planned for, is it that you wanted to get someone from each group, did you pick particular children from each group for example?</p> <p>[00:47:15.08] Teacher: ermm...I picked... I usually pick the ones perhaps that aren't so sure at the beginning. So like Bradley, and Charlotte at the beginning, he didn't put his hand up, so I wanted to just be sure that, You know... ok you didn't know it at the beginning, but you know now don't you so that's great. that's why. And if I can't if there is nobody that stands out like that then I will just be quite random about it really.</p> |
|--|--|---|--|

|   |  |  |  |
|---|--|--|--|
| <p>Teacher then explains to the children that they now need to think about what they are going to be doing next. She emphasises that she expects them to think about what it is they will be doing in the next lesson about time.</p> |  |  | <p>[00:47:43.08] Interviewer: And then you asked what's coming next....Or did you say what's coming next [WATCHED VIDEO] Ah yes, so can you just talk me through, because you alluded to that earlier?</p> <p>[00:48:04.23] Teacher: Yes as well as the children sort of clarifying in their own minds what they have been learning. I do that at the end so that the other children can see what their next step is, in that lesson. They can see that oh yeah that group over there have been doing 5mins I'll probably be doing that next lesson. Now it doesn't really matter to me if they can't work it out exactly. Especially the more able they don't know what's coming next for them unless I'm working with them and I tell them. erm... It's just that knowing where they're going with it really.</p> <p>[00:48:46.29] Interviewer: So obviously this is one in a sequence of lessons, erm... were you happy with where they ended up. (YEAH) the majority of the class, did they all move on, did you feel that they had.</p> <p>[00:49:01.19] Teacher: I did pick up that the children who were doing the time differences, erm... they did that independently, in the next lesson. erm... that they these children here who were independently working here, and I had been round so they moved onto time differences as well, so they ended up just a bigger group really. erm...</p> <p>[00:49:25.01] Interviewer: You had more laptops and...</p> <p>[00:49:25.01] Teacher: yeah and I think there was six of those, so we had a much bigger group. But the ones that had already started went off and got on with it. And the others had the explanation about the numberline and that kind of thing. I think there was a few if I remember rightly, that I noted down weren't using the numberline correctly or were relying too much on their head and not getting them correct, so they sort of stayed with this group and had the explanation again.</p> <p>[00:50:00.28] Teacher: I think I asked them, erm... but I do usually ask is</p> |
|---|--|--|--|

there anybody who wants to or thinks they want to. And they are very good at doing that and being honest. i just have to watch because with some children if they are not very confident who always say I think i need to listen again. and so sometimes I just ignore them. Not ignore the request but think well actually I know best at this point, and I saw what you did yesterday and you need to be a bit braver and just have a go on your own now. And you know who those children are now anyway.

END

## Appendix 9.1

### NNS (DfEE, 1999) FfTM

#### The focus on direct teaching

**Directing:** sharing your teaching objectives with the class, ensuring that pupils know what to do, and drawing attention to points over which they should take particular care, such as how a graph should be labelled, the degree of accuracy needed when making a measurement, or how work can be set out...

**Instructing:** giving information and structuring it well: for example, describing how to multiply a three-digit number by a two-digit number, how to interpret a graph, how to develop a mathematical argument...

**Demonstrating:** showing, describing and modelling mathematics using appropriate resources and visual displays: for example, showing how to scribe numerals, showing how to measure using a metre stick or a protractor, demonstrating on a number line how to add on by bridging through 10, using a

thermometer to demonstrate the use of negative numbers...

**Explaining and illustrating:** giving accurate, well-paced explanations, and referring to previous work or methods: for example, explaining a method of calculation and discussing why it works, giving the meaning of a mathematical term, explaining the steps in the solution to a problem, giving examples that satisfy a general statement, illustrating how the statement  $7 - 3 = 4$  can represent different situations...

**Questioning and discussing:** questioning in ways which match the direction and pace of the lesson and ensure that all pupils take part (if needed, supported by apparatus or a communication aid, or by an adult who translates, signs or uses symbols), listening carefully to pupils' responses and responding constructively in order to take forward their learning, using open and closed questions, skilfully framed, adjusted and targeted to make sure that pupils of all abilities are involved and contribute to discussions, allowing pupils time to think through answers before inviting a response...

**Consolidating:** maximising opportunities to reinforce and develop what has been taught, through a variety of activities in class and well-focused tasks to do at home, asking pupils either with a partner or as a group to reflect on and talk through a process, inviting them to expand their ideas and reasoning, or to compare and then refine their methods and ways of recording their work, getting them to think of different ways of approaching a problem, asking them to generalise or to give examples that match a general statement...

**Evaluating pupils' responses:** identifying mistakes, using them as positive teaching points by talking about them and any misconceptions that led to them, discussing pupils' justifications of the methods or resources they have chosen, evaluating pupils' presentations of their work to the class, giving them oral feedback on their written work...

**Summarising:** reviewing during and towards the end of a lesson the mathematics that has been taught and what pupils have learned, identifying and correcting misunderstandings, inviting pupils to present their work and picking out key points and ideas, making links to

other work in mathematics and other subjects, giving pupils an insight into the next stage of their learning...

Direct teaching and good interaction are as important in group work and paired work as they are in whole-class work but organising pupils as a ‘whole class’ for a significant proportion of the time helps to maximise their contact with you so that every child benefits from the teaching and interaction for sustained periods.

(pp12-13)

## Appendix 9.2

### PNS (DfES,2011): Ten approaches to the teaching of mathematics

#### Chapters

1 Guidance paper: Mathematics and the primary curriculum

2 Why is mathematics important?

3 So what is mathematics?

4 Ten approaches to the teaching of mathematics

5 Summary of what mathematics teaching should achieve

6 Questions

#### Section 4: Ten approaches to the teaching of mathematics

1. Plan and provide a balanced experience that incorporates the **exploration, acquisition, consolidation** and **application** of knowledge and skills, with opportunities to use, extend and **test ideas, thinking and reasoning**.
2. Share the **excitement of learning** mathematics and capture children's imagination by showing them the unusual or unexpected; give children examples of numbers or shapes that have special or surprising properties; show children how mathematics can be used creatively to represent, measure, predict and extrapolate to other situations.
3. **Model** for children how to explore mathematics and look for patterns, rules and properties; **direct and steer children's learning** by providing examples that enable them to observe and identify the rules and laws and deduce for themselves when they apply; help children to describe, replicate and use patterns and properties; ensure that they meet both general applications of the rules and exceptions.
4. Give children opportunity to **consolidate** their learning; introduce frequent and regular periods of **practice** that are short, sharp and focused on children securing, with the necessary accuracy and precision, the mathematical knowledge, understanding and skills they have learned; ensure that they recognise how their learning builds on previous learning and help them to see connections; ensure that they feel appropriately supported and challenged by the work they are set.
5. **Engage** with children's thinking; give them sufficient **time for dialogue and discussion and space to think** about their ideas, methods and mathematical representations of the real world; focus on underlying concepts and processes with prompting and probing questions.
6. **Demonstrate** and promote the correct use of **mathematical vocabulary** and the interpretation and **use of symbols, images, diagrams and models** as tools to support thinking, problem solving, reasoning and communication.
7. Provide children with the **well-directed opportunity to use and apply** what they have learned to solve routine and non-routine problems; highlight any properties or patterns they

identify or create and make connections to other work they have done; draw on their ideas and model approaches and strategies children can use to support a line of **enquiry** or to interpret or explain their results and methods, using their own approaches and strategies.

8. Teach children how to **evaluate solutions and analyse methods**, deciding if they are appropriate and successful; help children to understand why some methods are more efficient than others; provide opportunities to compare and measure objects and identify the extent to which shapes and calculations are similar or different; develop children's understanding and language of equivalence and deduction to support reasoning and explanation.

9. Periodically identify the knowledge, skills and understanding children acquire; pause and take stock to **review children's learning** with them; highlight the strategies and processes upon which they are able to draw; provide opportunities that allow children to make connections and show how ideas in mathematics relate, and how their learning can be applied to new aspects of mathematics.

10. **Model** with children how they identify, **manage and review** their own learning; highlight the **learning skills** they have acquired and used and draw out how these might be applied across the curriculum.

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(2011, pp.1-3)

## **Appendix 9.3**

### **Examples of target setting emphasis**

Here are some examples that can be downloaded from the internet from local authority websites to illustrate the continued emphasis in training and expectations on detailed assessment strategies.

This example is from Kent CC: Advisory Service Kent (ASK) to illustrate how local authorities provide a range of resources for their schools where target setting is part of the recent focus in training.

#### NNS Objectives and National Curriculum Levels

| Reception | Early Learning Goals                           |
|-----------|--|
| Year 1    | Level 1, and start on Level 2                  |
| Year 2    | Consolidation of Level 2, and start on level 3 |
| Year 3    | Revision of Level 2, but mainly Level 3        |
| Year 4    | Consolidation of Level 3, and start on Level 4 |
| Year 5    | Revision of Level 3, but mainly Level 4        |
| Year 6    | Consolidation of Level 4, and start on Level 5 |

The first two strands are presented below on Numbers and the Number system and calculation.

## Mathematics Targets Numbers and the number system

Class / Set

Date

|    | Targets  | Children's names |
|----|--|------------------|
| R  | Say and use number names in order in familiar context<br>Count reliably up to 10 everyday objects<br>Recognise numerals 1 to 9   |                  |
| Y1 | Count reliably at least 20 objects<br>Count on and back in ones from any small number<br>Count in tens from and back to zero<br>Read, write and order numbers from 0 to at least 20<br>Use the vocabulary of comparing and ordering numbers to 20  |                  |
| Y2 | Count, read, write and order numbers to at least 100<br>Know what each digit represents, including 0 as a place holder, in any two-digit number<br>Describe and extend simple number sequences, including odd/even numbers<br>Count on or back in ones or tens from any two-digit number   |                  |
| Y3 | Read, write and order whole numbers to at least 1000<br>Know what each digit represents in three-digit numbers<br>Count on or back in tens or hundreds from any two- or three-digit number<br>Recognise unit fractions such as $\frac{1}{2}$ , $\frac{1}{3}$ , $\frac{1}{4}$ , $\frac{1}{5}$ , $\frac{1}{10}$ and use them to find fractions of shapes or numbers<br>Understand and use £.p notation |                  |
| Y4 | Use symbols correctly, including less than (<), greater than (>), equals (=)<br>Round any positive integer less than 1000 to the nearest 10 or 100<br>Recognise simple fractions that are several parts of a whole<br>Recognise mixed numbers and simple equivalent fractions  |                  |
| Y5 | Multiply and divide any positive integer up to 10 000 by 10 or 100 and understand the effect<br>Order a given set of positive and negative integers<br>Use decimal notation for tenths and hundredths<br>Round a number with one or two decimal places to the nearest integer<br>Relate fractions to division<br>Relate fractions to their decimal representations                                   |                  |

|           |  |  |
|-----------|--|--|
| <b>Y6</b> | <p>Multiply and divide decimals mentally by 10 or 100, and integers by 1000, and explain the effect</p> <p>Order a mixed set of numbers with up to three decimal places</p> <p>Reduce a fraction to its simplest form by cancelling common factors</p> <p>Use a fraction as an operator to find fractions of numbers or quantities<br/>(e.g. <math>\frac{5}{8}</math> of 32, <math>\frac{7}{10}</math> of 40, <math>\frac{9}{100}</math> of 400 cm)</p> <p>Understand percentage as the number of parts in every 100</p> <p>Find simple percentages of small whole-number quantities</p> |  |
|-----------|--|--|

## Mathematics Targets Calculation

Class / Set

Date

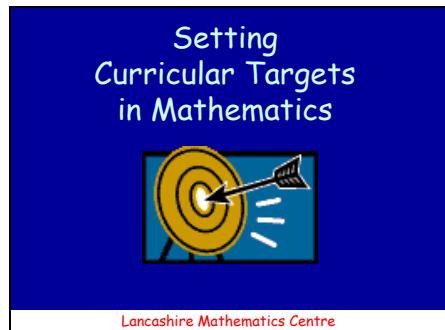
|    | Targets  | Children's names |
|----|--|------------------|
| R  | Use language such as more or less, greater or smaller to compare two numbers<br>Find one more and one less than the given number of objects from 1 to 10<br>In practical activities and discussion, begin to use vocabulary involved in adding and subtracting.<br>Begin to relate addition to combining groups of objects, and subtraction to 'taking away'.  |                  |
| Y1 | Understand the operation of addition, and of subtraction (as 'take away' or 'difference'), and use the related vocabulary.<br>Within the range 0 to 30, say the number that is 1 or 10 more or less than any given number.<br>Know by heart all pairs of numbers with total of 10.   |                  |
| Y2 | Understand that subtraction is the inverse of addition; state the subtraction corresponding to a give addition and vice versa.<br>Know by heart all addition and subtraction facts for each number to at last 10.<br>Use knowledge that addition can be done in any order to do mental calculations more efficiently.<br>Understand the operation of multiplication as repeated addition or as describing an array.<br>Know and use halving as the inverse of doubling.<br>Know by heart facts for the 2 and 10 multiplication tables. |                  |
| Y3 | Know by heart all addition and subtraction facts for each number to 20.<br>Add or subtract mentally a 'near multiple of 10' to/from a 2-digit number.<br>Know by heart facts for the 2, 5 and 10 multiplication tables.<br>Understand division and recognise that division is inverse of multiplication.   |                  |
| Y4 | Use known number facts and place value to add and subtract mentally, including any pair of two-digit whole numbers.<br>Carry out column addition and subtraction if two integers less than 1000 and column addition of more than two integers. less than 1000.<br>Know by heart facts for the 2, 3, 4, 5 and 10 multiplication tables.<br>Derive quickly division facts corresponding to the 2, 3, 4, 5 and 10x tables.<br>Find remainders after division.   |                  |
| Y5 | Calculate mentally a difference such as 8006 – 2993.   |                  |

|           |   |  |
|-----------|---|--|
|           | Carry out column addition and subtraction of numbers less than 10 000.            |  |
|           | Know by heart multiplication facts to $10 \times 10$ .                            |  |
|           | Carry out short $\times/\div$ of a 3-digit number by a single digit integer.      |  |
|           | Carry out long multiplication of a two-digit by a two-digit integer.              |  |
| <b>Y6</b> | Carry out column addition and subtraction of numbers involving decimals.          |  |
|           | Derive quickly division facts corresponding to multiplication to $10 \times 10$ . |  |
|           | Carry out short multiplication of numbers involving decimals.                     |  |
|           | Carry out short division of numbers involving decimals.                           |  |
|           | Carry out long multiplication of a three-digit by a two-digit number.             |  |

## Example 2: Lancashire CC

### Maths Advisory team power-point training for school staff meetings

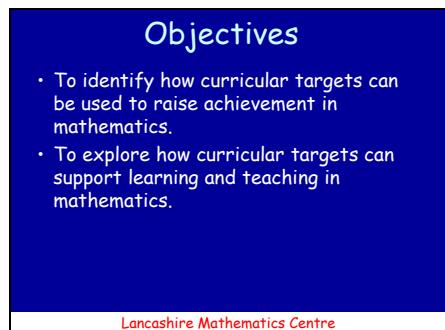
Slide 1



Slide 1

Introduce the staff meeting.

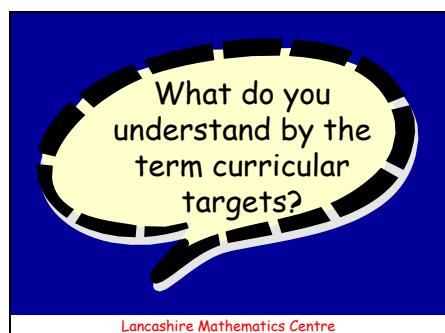
Slide 2



Slide 2

• Explain the objectives for the staff meeting which will last between 45 minutes and 1 hour.

Slide 3



Slide 3

- Pose the question, allow a couple of minutes for teachers to discuss this question in pairs.
- Take feedback on what they understand by the term.
- Make the point that curricular targets are not what they used to be i.e. 30 different targets in a class at one time, children and teachers not aware of targets and no means of helping the children achieve their targets.
- The focus now is on manageability otherwise curricular targets will not be effective.

## What is a curricular target?

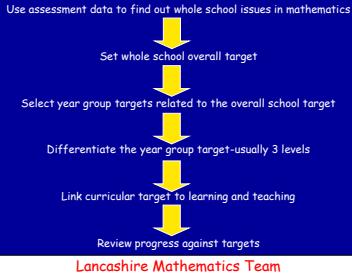
A curricular target is a clearly defined performance aim within a specific area of the curriculum. The purpose of setting curricular targets is to provide a focus for your efforts to raise standards, bring about curriculum development and arrange staff training and resource allocation.



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- Read the quote.
- Explain that numerical targets are what we want the children to achieve in terms of National Curriculum levels. They are useful in that they set high expectations but they do not indicate which aspects of maths children have understood and which are still causing difficulty.
- Curricular targets are the stepping stones of helping children to achieve a numerical target.
- It is important that teachers continue to work on all objectives from medium term plans, curricular targets can run alongside daily lesson objectives.
- Make reference to the new Teaching and Learning Materials-show the blue book which highlights to process of layering curricular targets.

## The Layering Model for Curricular Targets



- How to set curricular targets? Curricular targets are now often referred to as 'layered curricular targets'-this is because they are adapted to suit particular year groups and ability ranges.
- Go through and discuss the layering model flowchart:
- *Use assessment data to identify whole school issues in mathematics*-Make reference to the fact that now schools usually do SATs question by question analysis. It is crucial to go back to actual SATs papers to investigate what exactly the children did wrong e.g. was it a calculation issue, did not comprehend question or did they not understand the concept? Explain that book scrutinise and teacher assessment can also be used to identify areas for curricular targets. Schools use their evaluation and assessment tools to highlight areas of underachievement common to the whole school. This information can be used to:
- *Set whole school overall target*-for example-to develop children's recall of multiplication facts-this target will be time related-often lasting a half term, so there will usually be 6 targets across a whole school year.
- *Select year group targets related to the overall school target*-Use NNS Framework to ensure that the class target meets age related expectations.
- *Differentiate the year group target-usually 3 levels*-The year group target will be what is expected of the majority of the children in the class as this is linked to age related expectations from the NNS-this is known as the 'should' target. In all classes there are a range of abilities and therefore the target is differentiated by looking to the year groups below and above-these are known as 'must' (for less able) and 'could' (for more able).
- *Link curricular target to learning and teaching*

It is very important that targets are shared with the children and frequent reference is made to the target.

It is helpful if targets are displayed in a prominent place in the classroom in child friendly language-I can...

Use mental and oral starter sessions to provide opportunities to work on the class targets.

The target can be incorporated once or twice every week in a mental/oral starter session to keep the target 'on the boil.'

This should be identified on short term planning to identify focussed teaching.

- Make the point that everyone must continue with medium term plans and the rest of the maths curriculum, curricular targets are not instead of the rest of the curriculum.
- *Review progress against targets*-At the end of the identified period, progress against targets should be reviewed. This does not mean that all children must do a formal test, rather Assess and Review sessions can be used and teachers may assess through observation, questioning, discussion and activities.
- Children should be encouraged to evaluate their own performance and engage in peer evaluation frequently and at the end of a half term.
- Brief records will need to be kept in cases where children do not achieve the target and where children exceed expectations-this could be incorporated into current record keeping systems, for example keeping records of key objectives. This information must be used to inform planning in the following term.
- It is important to note that although a curricular target may have been a focus for a previous half term, it may be helpful to revisit these topics occasionally in mental/oral starters.
- *Set new targets*-The process begins again with a new area for development in a new half term.

## Slide 6

**How?**

- Share targets with the children and make links to whole school target
- Display target
- Plan specific teaching time
- Use 'spare' moments
- Incorporate a range of activities
- Parents
- Homework
- Whole school display
- Encourage regular reflection on progress

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## Slide 6

• Go through the suggestions on the slide for how to incorporate targets into learning and teaching  
Share targets with the children and make links to whole school target-everyone in school is working towards a related target.

Display target in the classroom in child friendly speak-possibly with key vocabulary or prompts.

Plan specific teaching time-2 mental/oral starters.

Use 'spare' moments-line up time, snack times etc.

Incorporate a range of activities-consider different learning styles e.g. songs, problems, practical activities etc.

Parents-inform parents at the start of each half term, this could be in the form of a brief newsletter which might give some suggestions

of some activities that they might work on at home to support their child

Homework-link homework activities to the class target, where appropriate.

Whole school display-in a prominent place in school-each teacher could take responsibility for one half term-this reinforces whole

school approach.

Encourage regular reflection on progress towards the target-ask children to reflect on how they think they are getting on, what could

they need to do now to achieve target.

Slide 7

## SMART

- **S**pecific
- **M**easurable
- **A**chievable
- **R**ealistic
- **T**ime-related

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Slide 7

•For a long time we have been familiar with the term 'SMART' targets, go through each letter and explain that the layering model of setting curricular targets is all of those things.

Slide 8

**Next steps**

| My Maths Targets  |
|---|
| To develop an appreciation of mathematics as a source of enjoyment and enrichment.                  |
| 10 Work on more challenging problems than those they previously solved.                             |
| 10 Solve a problem involving the concept of what is a common multiple, then discuss it with others. |
| 10 Work on more challenging problems than those they previously solved.                             |
| 10 Solve a problem involving the concept of what is a common multiple, then discuss it with others. |
| 10 Work on more challenging problems than those they previously solved.                             |
| 10 Solve a problem involving the concept of what is a common multiple, then discuss it with others. |
| 10 Work on more challenging problems than those they previously solved.                             |
| 10 Solve a problem involving the concept of what is a common multiple, then discuss it with others. |
| 10 Work on more challenging problems than those they previously solved.                             |
| 10 Solve a problem involving the concept of what is a common multiple, then discuss it with others. |

- Look at the targets for the children in your own class.
- Consider some activities to promote these targets.

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Slide 8

- Give out copies of curricular targets to all teachers for next half term.
- Ask teachers to consider the targets for the children in their own classes.
- Ask the teachers to discuss in pairs some of the types of activities that they might work on to promote these targets-allow 5/10 minutes for this and then take feedback-write up some activity ideas that can be shared with everyone

Slide 9

**Key messages**

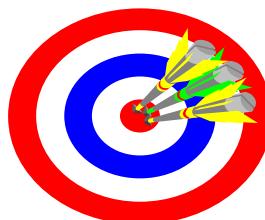
- Where possible, there should be a common theme across the school.
- Share targets with the children to ensure that they have ownership.
- Plan opportunities to focus on targets.
- Keep breadth in the mathematics curriculum.
- Encourage regular reflection on progress.

Slide 9

Key messages

- Common approach across the whole school.
- Share targets with children-make point that we will never get to where we want if we don't know where to aim for.
- Link targets to learning opportunities.
- Don't just focus on the target, teach the rest of the objectives from the medium term plan to ensure the breadth of study.
- Make children active partners in their own learning-reflect regularly.

Feed forward – target setting and informed planning



**Individual Target Setting**

*Why?*

- Ensures pupil motivation and involvement
- Promotes progress and raises achievement
- Keeps the teacher informed of individual need

*How?*

- Provide constructive suggestions about ways to improve
- Agree the next steps with the pupil
- Negotiate individual pupil targets – at Primary level for literacy and numeracy and at Secondary level for all subjects

*Informed Planning*

This is something that Ofsted Inspections are focusing on.

*Why?*

- Ensures the children are taught the skills and knowledge that they need to move forward

- Focuses on the teaching and learning and not the task

*How?*

- Use the information gained to adjust future teaching plans and make the changes obvious
- Celebrating Achievement*

### Why?

- Celebrating achievement builds self esteem which is the most significant factor in being a successful learner
- Achievement in one area builds confidence in future goals and in other areas

*How?*

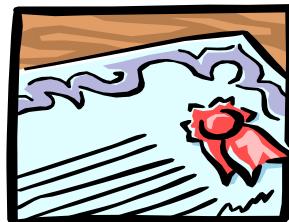
- Build a reward system that is easily understood by all participants
- Acknowledge, and treat similarly, achievements in different areas of knowledge, skills, understanding and behaviour
- Make explicit any links between achievements
- Ensure that the system does not reinforce lack of success for the less able
- Ensure that external rewards do not encourage the children to focus on the reward rather than the achievement



### **Individual pupil targets**

#### **Individual pupil targets are likely to help learning if they:**

- tell the pupil what aspects of their performance to focus on and improve
- are close to the action in time and space arising directly from feedback and feeding directly into classroom activity
- establish the next most achievable target
- consist of a description of the knowledge, skill or understanding aimed for by the pupil
- are tightly defined in order to be achievable
- are negotiated with the child
- relate to key learning objectives or assessment criteria
- are recorded in a specific place, so that the pupils know where to find them and have easy access to them
- are referred to whenever that is helpful, and do not lie dormant
- enable the pupils and teacher to refer back as well as forward not just telling the pupils what to aim for, but helping them plot the progress they have been making
- are manageable in number and scope for the pupil to accomplish and for the teacher to keep track of
- leave room for other spontaneous and worthwhile pursuits and unanticipated outcomes, and do not take over everything you do.



### Recording Individual Pupil Targets

**The important point to consider is that the targets need to be accessible to the children. Individual pupil targets have a positive effect on children's learning when they are close to the action and are referred to whenever appropriate.**

#### **Some suggested recording strategies:**

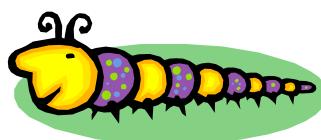
- written on the inside front cover of the children's exercise books



- written in a special ‘target book’
- written on a bookmark and kept in the children’s exercise book
- written in the middle of a flower/rosette and a petal/ribbon coloured in each time the target is hit



- written on a ‘writing worm’ or ‘target tiger’ or ‘maths millipede’



- written on a standing card and kept in the children’s drawers

#### Points to consider

- Do our plans identify clear learning objectives?
- Do our short-term plans show how assessment has affected the development of activities?
- Do our short-term plans contain assessment notes on children who need more help or more challenge?
- Do we use a range of questioning techniques and allow children time to think?
- Do we share learning objectives and assessment criteria with the children?
- Do our children evaluate their own learning?
- Does our feedback inform the children of their strengths and weaknesses?
- Does our feedback provide clear strategies for improvement?
- How are pupils encouraged to respond to feedback?
- On what subjects will pupil targets be set?
- Will they be for individuals or groups?
- How will they be negotiated?
- What will they sound like?
- How will they be recorded?
- How will they be monitored and reviewed?
- How will achievement be celebrated?