TEACHERS THINKING ABOUT AND USING PEER GROUP DISCUSSION IN PRIMARY SCIENCE

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Abstract

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The teaching of primary science is a demanding enterprise and teachers are encouraged to use peer group discussion tasks in order to engage pupils and support the development of understanding. However, drawing on this strategy and exploiting the power of group talk in science is challenging. The principal aim of embarking on my research was to seek understandings of the routine ways in which primary teachers are able to facilitate productive group talk.

This exploratory, qualitative case study incorporates a structured examination of classroom practice with regard to peer group discussion. The participants were three teachers from different English primary schools and their classes of 8-9 year olds. The fieldwork was conducted over the course of an academic year and interviews were carried out with teachers at the beginning and end of this phase. Observations of classroom practice were made at regular intervals through the year and audio recording of pupils’ group discussions were taken. Based on the premise that exploring teacher thinking provides a useful tool for understanding how teachers navigate tricky areas of practice, such as facilitating productive peer group talk in science, oral diaries were used to capture the post lesson reflections of teachers. Alongside these methods, group interviews revealed pupil perspectives on the learning through talk.

Rich descriptions of classroom practice woven with participant perspectives reveal situated understandings of teachers and pupils using group talk in science and they illuminate the wide-ranging implicit challenges faced. This story of teachers’ shifting epistemological beliefs through the routine use of peer group discussion provides a contribution to knowledge by extending our understanding of some factors which may constrain and promote routine talk opportunities in science. The research findings have implications for professional development programmes which aim to promote dialogic pedagogy in primary science classrooms.
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1. Introduction
The teaching of primary science is a tricky business covering a range of aims from the development of conceptual understanding and inquiry skills to the fostering of positive attitudes towards science and scientific literacy. Enthusing children, capturing their creative ideas and challenging them takes expertise, commitment, subject knowledge and time. Of course in the tight schedules of primary school life, science can get squeezed and so teachers require efficient, exciting and thoughtful practices in order to succeed with pupils. One way in which teachers are encouraged to work is through the use of peer group talk which is seen as an important, dynamic and creative context for science learning, popular with teachers and pupils (Howe and Tolmie, 2003, Howe et al, 2007, Jocz, Zhai and Tan, 2014, Murphy and Beggs, 2005).

Extensive training is available for schools around talk for learning, particularly focussed on the core curriculum area of English. Through my own practice as a primary school teacher, applying this particular pedagogy to science lessons emerged as a personal area of interest as I considered the ways in which I was able to engage my pupils in group discussion which facilitated their understanding. My professional interest developed into this more structured case study which is concerned with the use of peer group talk in primary science and focusses upon teacher thinking within this context. Through this thesis, I chart the professional journey of three primary school teachers working with peer group talk in everyday science lessons and I reveal the pedagogic tensions they experienced during the process. In order to set the wider context of the study, I will first briefly explore the position of primary science teaching.

1.1. English primary science: a developing picture

Primary science teaching in England has undergone dramatic changes in the last fifty years, the process being an evolution of ideas and practices (Richards, 2001). During the 1960s teachers and head teachers needed convincing of the case for science in primary schools and establishing a philosophical basis for it was led by the Nuffield Junior Science Project (1967), which presented a child-centred approach to science. Soon after, a lengthy Schools Council project, Science 5/13 (Harlen, 1975) laid down a thorough statement of the broad aims of teaching science to young children and this was supplemented by a series of teacher books with practical experiences for pupils.
In 1983, after a systematic monitoring of standards, the Assessment and Performance Unit set out expectations in different areas of science for pupils at age 11 but the real catalyst for massive teacher education (Feasey, 2001) was the introduction of the National Curriculum documentation in 1989, following The Education Reform Act (DES, 1988). The new science curriculum, now a core subject, sought to bring entitlement and continuity to pupils and to standardise the content taught across schools. This content, subsequent revisions and teacher guidance were strongly influenced by findings from major research projects:

- The SPACE project (Science Processes and Concept Exploration Project 1989-1998), led by Harlan and Black, had far reaching influences in terms of showing teachers the importance of understanding children’s own scientific ideas and using them as a starting point for developing understanding. A series of research reports and teaching materials were developed and widely used in classrooms (e.g. Nuffield Primary Science, 1993, Osborne, Wadsworth and Black, 1992).
- The CLIS Research Group (Children’s Learning in Science Project, 1987) investigated progression in children’s ideas and provided advice when the National Curriculum was revised. The project set out to explore the nature of children’s ideas and how this understanding could be used to develop teaching approaches which promote conceptual change.
- In New Zealand, the Learning in Science Project (e.g. Osborne and Freyberg, 1985) paralleled the research on children’s ideas in science being conducted in this country; findings supported those of English projects.

These studies presented to teachers an over-arching pedagogy of constructivism for the teaching of science and also tried to convince of the benefits and necessity of scientific investigation work (National Curriculum Council, 1993) although it has been argued that these curriculum documents portrayed narrow definitions of the latter (Eady, 2008). Projects focussing attention on developing children’s inquiry skills were created, for example the AKSIS Project (Watson, R., Goldsworthy, A. and Wood-Robinson, V., 1998) and further recommendations on broadening science investigation work were made (e.g. Goldsworthy, Watson and Wood-Robinson, 2000).
Science remains a core subject within the primary National Curriculum in England (Department for Education, 2014) and it plays an important role in developing future citizens who are able to understand the uses and implications of science in their lives. What this means is that learning science is for all children, not just those who see their future in a scientific career. This universal goal for science education is commonly expressed as developing ‘scientific literacy’. An influential report regarding aims for science education (Millar and Osborne, 1998) refers to scientific literacy as being a confidence and competence with and appreciation of science such that individuals are informed citizens, empowered to understand and respond critically to the science which impacts upon them or is under public debate.

Within this goal of scientific literacy for all, other purposes for science education are situated such as the development of understanding of scientific ideas; the fostering of inquiry skills; the promotion of positive attitudes to science and the development of language and communication skills (Harlen, 2008, Harlen, 2011). Understanding science as a way of working and knowing is also an important component of developing scientific literacy and taking this approach provides a richer and more meaningful learning experience (Duschl, 2000, Lederman, 1992). This involves introducing pupils to the epistemic basis of science, known as the nature of science; the practices of the scientific community, and their ways of knowing, thinking and communicating (Lemke, 1990, Scott and Ametller, 2007, Wellington and Osborne, 2001). More generally, the potential science teaching holds for engaging pupils in the constructive debate of ideas which is central to scientific thinking (Gillies, 2013, Osborne and Chin, 2010) ‘enables important goals of learning, for understanding and for learning how to learn, to be achieved’ (Harlen, 2004, p.19).

If we take the theoretical position that language is a tool for joint construction of understanding, which will be explored in Chapter Two, then it follows that language has a central role to play in the development of science (Driver, Newton and Osborne, 2000, Lemke, 1990, Sutton, 2005) which itself is a human endeavour, a way of thinking, talking and communicating centred on the development of understandings about the world. Whilst a community of scientists is different to a community of young learners of science there is still a common foundation within which discourse takes a
role (Osborne and Chin, 2010). Therefore engaging pupils in group talk has the potential to contribute to a range of goals for science education, including supporting understanding, developing inquiry skills and fostering views of science as a social practice (Driver et al, 1994, Newton, Driver and Osborne, 1999, Pimentel and McNeill, 2013).

1.2. Challenges for primary science teachers

The demands on the timetable of a primary class in England, due to the National Strategies for Literacy and Numeracy introduced in the late 1990s unbalanced the ‘broad and balanced curriculum’ (DES, 1988) and impacted upon the amount of teaching time devoted to science (Boyle and Bragg, 2005, Braund, 2009, CBI and Brunel University, 2015, Murphy and Beggs, 2005), seeing it ‘on the backburner’ (Harlen and Qualter, 2014) and taught in short afternoon sessions in many schools (Ponchaud, 2001 in Beggs and Murphy, 2001). A focus upon formal assessments at the end of Key Stage Two (pupils aged 10/11) also led to pressure on teachers to teach the factual knowledge tested (Harlen and Qualter, 2014) indeed an audit culture has been cited as a factor constraining teachers from developing more creative and innovative ways of working (Craft and Jeffrey, 2008, Wallace and Kang, 2004). The removal in 2010 of mass external testing of eleven year olds’ science performance may over time alleviate such issues in England. The weight of curriculum within science itself may also impact upon the use of talk (Newton, Driver and Osborne, 1999). Keogh and Naylor (2007) suggest that it is this that may be a contributing factor to their finding that despite significant developments in the use of classroom talk in England, within science lessons talk is often an 'add-on' and not at the heart of lessons.

Pupils’ attitudes towards science also may present a challenge for primary teachers as research has shown that children tend to become more disillusioned with this subject after the age of nine (Beggs and Murphy, 2001, Osborne, Simon and Collins, 2003, Schibeci, 1984). They may also hold stereotypical perceptions, viewing scientists as a brigade of white coats; solitary workers in laboratories coming up with baffling theories for us to swallow (Mead and Metraux, 1957, Painter et al, 2006) rather than communicators, exchanging information and building upon each other’s thoughts,
socially negotiating understandings of events and phenomena to create a communal understanding of our world (Tobin, 1993). Importantly, primary teachers often lack relevant expertise in science (The Royal Society, 2014) and are not confident that their own scientific understandings are adequate to facilitate conceptual development and challenge children’s thinking (Asoko, 2000, Harlen, Holroyd and Byrne, 1995, Harlen, 1997, Murphy, Neil and Beggs, 2007, Newton and Newton, 2001). In addition, research has found that primary school teachers can have naive understandings of inquiry and the nature of science (Davis, Petish and Smithey, 2006). Hand in glove with these challenges is the call for more specifically tailored continuing professional development for primary teachers but at present, opportunities to enhance both science subject and pedagogical knowledge are seen to be lacking and this has an impact upon teacher confidence and creativity in the classroom (CBI and Brunel University, 2015, Murphy and Beggs, 2005, The Royal Society, 2010).

There are therefore real pedagogic and contextual challenges facing teachers of primary science which can impact upon the enactment of their ideals for science teaching and learning (Mansour, 2009) but the wonder of science is a powerful motivator and teaching it can be a privilege and a pleasure as children explore their understandings of the world. There are a range of suggestions for developing learning experiences such as making school science more relevant to children’s lives, using inquiry or creative, practical contexts and first hand experiences. Other strategies for developing science learning follow differing themes, such as planning for cognitive conflict, (Chan, 2001, Keogh and Naylor, 1999, Williams and Tolmie, 2000) or using the written word as a tool for reflection on understandings (Ruiz-Primo et al, 2010). One other purposeful approach is group work and the use of peers talking with one another to be ‘working on understanding’ (Barnes, 1992, p.5). Pupil-pupil interaction has been found to be a productive forum for achieving conceptual development in science (Howe et al, 2000, Howe and Tolmie, 2003, Howe et al, 2007, Baines, Blatchford and Chowne, 2007) and therefore this study is concerned with peer group talk as a forum for the social construction of understandings in the classroom (Edwards and Mercer, 1987, Lemke, 1990, Solomon, 1993).
1.3. **A focus on classroom talk**

Beginning with the acknowledgement in the Bullock Report (Bullock and Department of Education and Science, 1975) that children learn through talk, over the last few decades in England classroom talk has been highlighted as being of central importance for the development of children’s thinking and communication skills. A wide range of early studies observed and analysed classroom talk, revealing the developmental processes occurring (Barnes, 1976, Barnes and Todd, 1977, Cazden, 1988, Edwards and Mercer, 1987, Wells, 1987) and the work of the National Oracy Project (Norman, 1992), prioritised the role of talk for learning. The National Curriculum (DES, 1988) and Primary National Strategy (Primary National Strategy and QCA, 2003), where speaking and listening were given a high priority within the documentation, underlined for classroom practitioners the importance of high quality dialogue for learning and this emphasis was retained when the new National Curriculum (Department for Education, 2014) was published. Western pedagogy in particular now emphasises the importance of talk, seeing it as crucial for effective teaching (Howe and Abedin, 2013) yet there is still a strong interest among practitioners for developing further professional understandings of the role of language for learning (Mercer and Dawes, 2014).

1.4. **Language for learning**

The publication in English of Vygotsky’s work (1986) on conceptual development and his thesis that speech and thought develop together under reciprocal influence, brought attention to the role language performs in the formation of higher level thinking. He suggested that socially meaningful interaction generates individual conscious thought; that talk is a social mode of thinking (Mercer, 1995), a cultural and psychological tool which has the potential to construct collective understanding. Through this socio-cultural perspective, learners are an integral part of the social environment of the classroom; knowledge is seen as a personal construction created within a jointly mediated social context (Cole, 1996, Pelech and Pieper, 2010) and the role of the teacher is emphasised. Vygotsky (1978) prioritised ‘intermental’ functioning, cognitive processes occurring on the social level and viewed individual or ‘intramental’ processes as emerging only through the mastery of the social. Through
such joint action, there can be a ‘dynamic interplay and interaction of minds’ or ‘interthinking’ (Littleton and Mercer, 2013, p.8) and learners may be enabled to make sense of experience and develop new understandings which are then internalised. In this way, during the teaching of science, the provision of experiences within which learners interact with each other’s ideas can be seen as a rich arena for the joint construction of knowledge and may provide the ‘pedagogic means... the vehicles by which children develop more effective conceptual tools’ (Millar and Driver, 1987, p.56).

In recent years, there has been an increasing amount of research into the use of talk in classrooms and how its benefits can be maximised. The quality of dialogue, both within groups and between teacher and pupils, has been studied (Alexander, 2008c, Gillies, 2011, Mercer and Littleton, 2007, Mortimer and Scott, 2003). Teacher led dialogue in the classroom, whilst of central importance, alone is not sufficient. Children themselves need opportunities to engage with each other’s ideas, express themselves and hear fresh perspectives in peer groups (Dawes, 2004) in order to clarify their thinking, explore how they may relate to newly presented ideas and begin to reach an intersubjective position with their teacher. Through discussion, explanation and justification of ideas pupils can construct their understandings socially, make meaning as they try out new thinking, support each other’s tentativeness (Lyle, 1993) and consolidate their understanding. Pupil-pupil talk for learning requires children to do by themselves, something which has previously needed support (Edwards and Mercer, 1987) and can provide a space for children to nudge their understanding forward (Howe, 2014). The provision of peer group talk opportunities may foster an agentive disposition to learning (Haneda and Wells, 2010) and is strongly connected to constructivist approaches in science education which view the learner as active in the development of their own understandings (Driver, Guesne and Tiberghien, 1985, Piaget and Inhelder, 2000, Vygotsky, 1986).

Despite its theoretical underpinning and the empirical evidence for its benefits, both which will be explored later in this thesis, there are myriad challenges with the implementation of this dialogic pedagogy in the classroom, not least from the long established dominance of the written word as the valued format for the reproduction
of learning outcomes. Beliefs about the priority of assessment and accountability in science learning can have a constraining influence over beliefs about dialogic interaction and attention to social and collaborative aspects of peer group work can diminish emphasis upon its cognitive potential. In addition, a fear of losing control of the classroom and the learning intentions through the cultivation of more pupil centred ways of working is an understandable tension for practitioners. Science education brings further constraints as the need to enculturate pupils into the accepted views of the world can lead teachers to be enticed towards transmissive, repetitive pedagogic approaches. Vygotsky (1986, p.149) regarded these as fruitless activities which could not possibly lead to the ‘complex and genuine act of thought’ required for conceptual development.

Research has found that the peer group context is under exploited by teachers and productive talk rarely occurs (Alexander, 2008c, Cazden, 2001, Littleton and Mercer, 2013, Mercer and Howe, 2012). Teachers have few strategies at their disposal to maximise the power of talk, despite their enthusiasm (Bennett et al, 2010, Mercer, Dawes and Kleine Staarman, 2009) and there have been calls for further studies which explore both how and when talk flourishes (Wolfe and Alexander, 2008) and also the challenges faced by practicing teachers in using dialogic pedagogies during everyday classroom life (Howe, 2014, Reznitskaya et al, 2009). From a socio-cultural perspective, the teacher’s role in guiding the construction of knowledge is key; even when they are not present in the group discussion they have a scaffolding impact which comes from creating a supportive environment, ground rules for talk (e.g. Mercer et al, 2004) and developing the open ended tasks necessary for productive talk to emerge. In addition, alongside the consideration of organisational and collaborative issues, effective teaching both models and highlights appropriate, productive ways of communicating in order to develop pupils’ metacognitive understandings. Clearly, the teacher’s role is crucial when facilitating group discussion but also highly complex. It has been suggested that research is still needed on how science teachers may effectively organise and scaffold group work, encourage reflection and both monitor and guide group interactions (Baines, Blatchford and Chowne, 2007, Bennett et al, 2010, Howe

Calls ring clear in the literature for further research into the use of peer group talk, as does the articulation of the significant challenges for teachers with its classroom application. Therefore what may be beneficial is the development of further situated understanding of peer group talk in use, a rationale which informs the aims of this study.

1.5. Study aims and research question

The principal aim of embarking on this study was to seek understandings of the ways in which primary teachers successfully facilitate group talk and to explore how they create the social space for children to engage in productive and inquiring scientific discussion. New understandings of how peer group discussion in primary science successfully occurs may be interesting to practitioners, both experienced and trainee and could also be transferable to other classroom contexts.

The study is framed by the primary research question:

*How and through what processes do primary school teachers engage pupils in productive group talk in science?*

Supporting questions can also be articulated:

*What are teachers’ considerations regarding group talk in science?*
*What are teachers’ considerations when the talk is most/least successful?*
*What are pupils’ considerations regarding group talk in science?*
*In what ways does teacher thinking impact upon their practice of using group discussion?*
*How does teachers’ thinking about the use of group discussion change over time?*

An important clarification to make with regard to the primary research question is about the term ‘productive’. I have used Mercer’s (1995) typology of classroom talk as an analytical tool in this study and take the category of Exploratory Talk as the indicator for productive talk. Exploratory Talk represents an educated discourse and is critical, constructive, relevant and reasoned (Mercer, 2000).
1.6. Teachers’ thinking about the use of talk

Research which aims to identify how peer group discussion may be effectively scaffolded should explore the important perspectives of the teacher and the ways in which they consider, reflect upon and develop their practice. Therefore in order to begin to seek answers to the research questions, I have taken a focus on teacher thinking. This study is based upon the premise that behind the successful facilitation of productive peer group talk lays teacher thinking and it therefore makes sense to study teacher thinking because of its reciprocity with practice (Van Driel, Berry and Meirink, 2014). Teachers’ experiences of utilising peer group talk in science can shape their ways of thinking and these in turn impact significantly on their evolving practice and their pupils’ learning opportunities. Capturing and exploring teacher thinking can provide interesting, subjective and contextualised accounts of professional activity which have the potential to provide insight into how teachers create learning opportunities, make sense of the educational environment in their classroom (Pope, 1993) and navigate tricky areas of practice such as the facilitation of productive group talk in science.

As part of the structure of their thinking, teachers hold epistemological beliefs; those which are concerned with the nature of valid knowledge and how it can be understood (Hashweh, 1996, Pajares, 1992). These kinds of teacher beliefs are of particular interest in science education where understanding the nature of science is an important learning aim for pupils. Epistemological beliefs form a complex network of ideas which influence what teachers prioritise for their students to learn and how they provide learning opportunities (Hashweh, 1996, Lederman, 1999, Mansour, 2013, Tsai, 2002, Wallace and Kang, 2004, Waters-Adams, 2006) but research also shows that oftentimes this creates significant tensions for teachers of science who in practice, may have to reconcile their own differing epistemological positions and resolve internal contradictions. In addition the congruency between beliefs and practice can be affected by contextualised socio-cultural factors (Phipps and Borg, 2009) and competing beliefs can bring tension for teachers in enacting their vision of practice (Bryan, 2003, Wallace and Kang, 2004).
Implicit beliefs about learning science and how collaborative dialogue can be situated within that process are therefore an important consideration in a study of teachers using peer group talk but the literature is not well populated with studies of primary school teachers’ beliefs about talk, the focus being mainly on secondary science practitioners. This study, which explores primary school teachers’ thinking and their beliefs and reflections over time, is therefore important because it will extend our understanding of the use of group discussion in science by providing a valuable insight into classroom practices in this area and pupils’ responses to them. The data collected can provide a window on the professional journey, shedding light on the triumphs, challenges and issues faced by primary school teachers when drawing upon this particular pedagogy in everyday practice and emerging themes and ideas can be incorporated into the available corpus of knowledge. The contribution to knowledge from this study will be particularly germane to the literature around primary teachers’ thinking about the routine use of classroom talk, where our understanding is less broad. This can have a potential impact upon professional development practice.

1.7. Methodological overview

To address the research aim and in order to capture a range of in depth perspectives on the same issue, fieldwork for this ethnographic case study was carried out over the course of a year in three different contexts; two larger than average primary schools within the same city and one smaller than average primary school in a large village setting. The participants were all Year 4 teachers (Emma, Simon and Arun – see Appendix 2.1 p.298 for pen portraits) and their classes of children, aged 8-9 years old. A range of research methods were employed including extended interviews with each teacher before and after the main classroom observation phase. Over the year, twenty two lessons in total were observed across the three classrooms. In addition, a reflective oral diary entry was collected from the teacher after each lesson in order to capture immediate thoughts about the learning and teaching. This diary was an important research method, designed to be a regular space for the elicitation and exploration of professional thinking about the use of group discussion. Further to this, the oral diary can be conceived as a space of deconstruction and reconstruction (Fook
Reflective thinking is well established as a tool for examining practice, querying situations and raising awareness of unconsciously held beliefs. The externalisation of such thinking is a vehicle for making sense of teaching experiences but also for moving forwards with fresh ideas and so it holds the potential to empower a teacher to find new ways of thinking about approaches with peer group talk.

All interview, observation and oral diary data were coded and analysed in an inductive, thematic way. In addition, a temporal analysis was used to look for changes in teacher thinking over time in terms of change themes (Shapiro, 1996). The temporal nature of the study also provided scope to look at how joint construction of understanding occurs through time, as participants draw upon shared history and build dialogic trajectories (Mercer, 2008).

From a socio-cultural perspective, pupils are participants who bring their own experience and perceptions to learning opportunities and their voice in research is valuable, yet seldom heard (Niemi et al, 2015, Rop, 2003). In this study richer insight into the nature and impact of teaching practices is possible through the contributions of pupil participants, which add a further dimension to the descriptions of classroom action and shape the way in which interpretations can be made. In each class a focus group of pupils was chosen; all of their group discussions during the science lessons were recorded and this data was supplemented with post lesson interviews with these pupils in order to gain their perspectives on learning outcomes and how talk had enabled them. The children’s talk was subject to Sociocultural Discourse Analysis (Mercer, 2004).

The number of teacher participants in this study is small and the nature of this interpretive study makes findings highly situated and contextualised but I do not seek to make claims about their generalisability. However, themes emerging may be transferable to new environments where practitioners could perhaps engage in new patterns of thinking in order to develop their own professional understandings.
1.8. Thesis outline

In this first chapter I have outlined some of the perspectives and issues relevant to my study. I have set the rationale by outlining both the challenges faced by primary teachers with the use of peer group discussion in science and by highlighting calls in the literature for further study in this area. This opening section also broadly introduces the methods I selected for use towards the search for answers to my research questions and provides an indication as to where this study may provide a contribution to existing literature. In Chapter Two I present the theoretical framework for the study, set boundaries from which it can be viewed and provide a review of relevant literature, focussing on approaches to primary science teaching, how talk may facilitate learning and the significance of teacher thinking for practice. Chapter Three provides an account of the methodology; of the way I worked, the decisions I made and the issues which arose throughout the research process. Chapter Four details the inductive analytic process I went through in order to deconstruct the data sets I had collected. The aim of this chapter is to present an audit trail, to show my ways of thinking and how I moved from the raw data to the presentation of my thematic analysis, which is the subject of the three following chapters.

Chapter Five explores how teachers’ ways of thinking developed over time to focus on constructivist issues around pupil ownership. The impact upon pupils of the changes in teachers’ ways of thinking will also be considered. Chapter Six examines how, in using peer group discussion, teachers draw upon epistemological beliefs related to science learning in relation to the use of inquiry. Temporal aspects are once again a focus in this chapter as well as the impact of teacher thinking on pupils’ learning experiences. The final presentation of analysis is Chapter Seven which examines tensions felt by the participating teachers in the use of peer group talk. This chapter draws in part upon a detailed analysis of extracts of peer group talk (Appendix 9.6b p.364) using the theoretical framework of the Intermental Development Zone (Mercer, 2000) and I explore the ways in which teachers enabled productive group discussion and contrast this to their planned purposes.

Finally Chapter Eight draws the thesis together and articulates the original contribution to knowledge. This centres on the fresh, situated understandings about
the complexity of primary school teachers’ routine use of peer group talk in science, factors which may constrain and promote it and the way in which teacher thinking around peer group talk changed over time. Some possible implications of this study are also suggested.
2. Literature Review
This chapter aims to explore a framework for the research and set boundaries from which it can be viewed. Firstly, I will outline concepts central to the study and make it clear how I have made connections between them in order to construct the theoretical framework for my study. Following this, I will explore the concepts, particularly those related to social constructivism and teacher thinking.

2.1. Theoretical framework

The overarching theoretical framework can be represented diagrammatically as in Figure 2-1. The basis of the framework is that teacher thinking about the use of group dialogue and what productive talk means in science has a reciprocal relationship with learning opportunities provided in the classroom. It is also influenced by the opportunities and challenges which science teaching present. This framework is based upon a model of teacher thinking described by Clarke and Peterson (1986). I have situated the framework within the unique cultural context of a classroom, rich with established beliefs and practices. This bounding is also represented in the diagram.

![Figure 2-1 Broad overarching theoretical framework for the study based upon Clarke and Peterson’s model (1986) of teacher thinking](image)

Each aspect of this broad theoretical framework can be probed further to reveal theoretical constructs which underpin this study. This is represented diagrammatically in Figure 2-2.
Figure 2-2. Overarching theoretical framework for the study based upon Clarke and Peterson’s model (1986) of teacher thinking, including underpinning concepts.
Crucial to this framework are the opportunities provided by the constructivist theoretical approach embedded within primary science teaching. This views learners as active agents in the development of their own understanding and teachers as facilitators of this process. This theoretical position is the foundation of Vygotsky’s (1978) social constructivist perspective which identifies language as vital for conceptual development. Through this lens, human cognition is fundamentally a social process mediated by the use of cultural tools, such as language and influenced by historical circumstances. Focussing further, a key theoretical concept for this study is Vygotsky’s emphasis on the potential of intermental work to influence an individual’s intramental construction of thinking. Mercer takes this Vygotskian stance in his studies of classroom interaction and identifies Exploratory Talk as a productive type of dialogue through which pupils are able to co-construct understanding (Mercer, 1995). Bruner’s (1983, 1986) work also focuses on the role of language in learning and his notion of scaffolding (Wood, Bruner and Ross, 1976) highlights the function of the teacher. Drawing on this, a further concept which supports this framework is that of the Intermental Development Zone (Mercer, 2000) which is helpful when considering how teachers may enable pupils to construct a shared dialogic space for the development of their thinking.

A cornerstone of the theoretical framework is that of teacher thinking; more specifically teacher beliefs. Beliefs are relevant to the theoretical framework because they are an important factor in the way individuals think and make assertions to themselves (Dewey, 1909) and they are seen to mediate classroom action (Pajares, 1992). Teachers’ deeply held epistemological beliefs influence decision making and exploring them holds real potential for gaining insight into classroom practice. A constructive exploration of experience through reflective thinking may also impact upon teacher action (Schon, 1983) and the reciprocal theoretical relationship depicted within the framework takes account of this.

In order to develop my understanding of the concepts within the theoretical framework and review the relevant literature, I conducted an initial search for academic papers and books. This was based on the key ideas of group work and discussion, teacher thinking and beliefs, dialogic classroom interaction, classroom
communication and conceptual understanding in primary science. Reports into the current status of primary science teaching in the UK were also searched. Initial findings from the main study prompted a further search for literature around the ideas inquiry-based science and the tensions involved in taking a social constructivist approach to science learning. Following this, electronic search and alert tools were used to keep myself informed of emerging relevant literature. In this way, the development of the theoretical framework has been informed by various sources (Maxwell, 2005); personal experiential knowledge, existing theories and understandings from the literature and also empirical study material which enabled me to pinpoint further considerations.

Through my review of literature I consider what is already known and not yet understood from research in the field of both peer group talk in science and teacher and pupil perspectives upon it. I have divided the chapter into three sections, each one relating to an area of the theoretical framework represented in the broad diagram (Figure 2-1). The first section provides a focus on opportunities and challenges specifically related to using constructivist, inquiry-based approaches to primary science. The second section focuses on classroom interaction, exploring social constructivist perspectives on how children may learn through dialogue and the scaffolding role the teacher takes. The third section unpacks certain dimensions of teacher thinking and considers its reciprocity with classroom action.

2.2. Opportunities and challenges for science teaching

2.2.1. Using constructivist approaches to learning science

One of the goals of science education is for learners to develop understandings that fit with presently accepted views; to share the knowledge and understanding, the visions and models of the world that science has created over time (Loxley et al, 2014).

However, children can struggle with the amount to learn, find the concepts abstract and the explanations counter intuitive (Murphy and Beggs, 2003). When pupils arrive in the classroom they will already have some knowledge, in simple terms, of the ideas that are encountered in science lessons (Driver, Guesne and Tiberghien, 1985, Duit
and Treagust, 2003). This everyday knowledge, good enough for day to day life, will potentially not be adequate in terms of scientific theory (Asoko, 2002) and these alternative conceptions may be difficult to shift (Allen, 2010). The job of the teacher of science is to introduce new ways of seeing the world, more rigorous and broadly applicable notions, so the learner develops more scientific ways of knowing about existing ideas. Tobin and Tippins (1993) make this point:

_The teacher, representing society, has an obligation to educate students, to assist them in learning what is currently regarded by society as viable knowledge_ (Tobin and Tippins, 1993 p.7).

This process of enculturation into the science view is where ‘the novice gradually constructs the organising cognitive structures for him or herself and brings his or her actions into conformity with the culture given pattern’ (Wells, 1999, p.323). The difference between these two ways of knowing has been labelled as the ‘learning demand’ (Leach and Scott, 1995, p.48), which is greater in some areas than others.

Primary science teaching can be thought of as enabling children to create a foundation of small ideas which helps them to understand their environment, make links between experiences and in the process construct bigger ideas. This constructivist approach to learning, now embedded in science teaching sees children as active agents, proceeding on an intellectual path together with their existing thinking; making sense of the world by testing their current understandings, building up new knowledge by modifying what they already know (Driver, Guesne and Tiberghein, 1985, Driver, 1989, Fensham, Gunstone and White, 1994, Scott, 1987, Duit and Treagust, 2003). Knowledge is viewed as a personal construction and the process of learning new knowledge is not about the transfer of facts to a passive individual but about the active process of personal construction. Learners develop new ideas about their world based on observations and experiences, which sometimes broaden and deepen their existing ideas yet sometimes challenge them (Gunstone, 1994, Pelech and Pieper, 2010). A conflict or disjuncture can prompt the learner to rethink, in order to come up with a scheme of thought that allows for a wider set of realities (Baviskar, Hartle and Whitney, 2009). In this way, the construction of knowledge can be a revisionary process, where ideas are replaced as new ones become available. This process
parallels the development of science, which is seen to be socially constructed by a community of scientists as a tool for organising information, explaining phenomena, solving problems and understanding the world rather than being a set of facts about the world waiting to be discovered (Kuhn, 2012).

The constructivist perspective upon knowing, broadly described above derives from the work on conceptual development by Piaget and Vygotsky. They both held theoretical positions which viewed mental processes as originating in action within the external environment which is subsequently internalised into individual psychological functions (Wood, 1998). Constructivist ideas about conceptual development are related to two different types of thinking – scientific (abstract, organised and structured; logical and systematic) and spontaneous (from everyday experience; disorganised; empirically rich) (Vygotsky, 1986). Piaget was preoccupied with spontaneous concepts which are characteristic of a child’s thought but Vygotsky (1986) argued that the two systems are interrelated, should not be seen as irreconcilable and that dialogue between individuals could be the tool which spanned the gap between them.

Piaget’s (2000) theoretical position held that learning occurs when spontaneous thinking adjusts itself towards more abstract scientific concepts and that adult ways of thinking supplant the child’s. From this perspective, concept development is seen as when the spontaneous way of thinking is displaced by an adult mode of reasoning; a process involving combat and compromise on the part of the child’s mental structures. Piaget placed emphasis on interactions with the material environment as the central factor which contributes to the development of intellect such that as children act upon objects within their world, they learn how to control it. In contrast, Vygotsky (1986) theorised that conceptual development was about the meeting between the two types of concept and that this occurred through instruction. Like Piaget, he understood this to be a developmental process with inward history but he emphasised the role of the social and cultural milieu in prompting higher order thinking. The role of spontaneous concepts was also crucial for Vygotsky (1986, p.148) seeing them as developing towards generalisation and complexity through concrete experience but that higher level and abstract scientific concepts require ‘systematic cooperation
between child and teacher’ for their evolution. His idea was that systematised thought provides structure and organisation for spontaneous concepts ‘remodelling them from above’ (Vygotsky, 1986, p.172), leading the child to higher levels of thought and this idea was central to his emphasis on the role of instruction in learning. I will build on this point when I return to Vygotsky’s ideas later in this review.

By applying constructivist pedagogy, teachers position children in a complex and interactive role which places demands upon them and their thinking (Prawat, 1992). Through the elicitation of pupils’ existing ideas, by accounting for misconceptions and by presenting appropriate learning experiences which challenge thinking (Gunstone, 1995, Naylor and Keogh, 1999, Prawat, 1992) and relate to pupil’s existing ideas (Baviskar, Hartle and Whitney, 2009), the teacher becomes a facilitator. In this way, learning starts with the children who generate their own understanding of scientific concepts (Harlen, 2007) and take active control over them through interaction with culturally accepted ideas (Daniels, 2001).

2.2.2. Using constructivist approaches to learning science – tension for teachers’ epistemologies

The constructivist theoretical position for teaching science appears relatively easy to accept yet during routine practice its use can be challenging. Fox (2001) suggests that it provides hopeful but perhaps over simplified promise and that in fact it is not a problem free approach. For example teachers can find it difficult to move beyond elicitation stages in the conceptual development process and literature can be too technical and lack emphasis on the application of theory, leading to misunderstandings. In addition, epistemological assumptions within the theory may stand in conflict with teachers’ own beliefs (Baviskar, Hartle and Whitney, 2009, Duit and Treagust, 2003, Naylor and Keogh, 1999, Mansour, 2009) which may be of a more traditional or didactic nature due to their own school science experience (Tsai, 2002). Prawat (1992) describes this as the dilemma of constructivist teaching; on one hand having an obligation to the powerful ideas of the discipline and on the other, honouring students’ efforts to make meaning; balancing this requires a sophisticated understanding of both students as learners and content. Because of this challenge,
Orland-Barak (2003) suggests that more situated understandings of constructivist pedagogies are required. From a study of her own efforts to utilise constructivist pedagogy in a postgraduate teacher development programme, she highlights the tensions that surfaced when two separate discourses come together - one related to processes of co-construction of meaning within learning opportunities and another related to the more product focussed requirement of clear cut answers and performance evaluation. When these two discourses rub alongside each other in the learning process, cracks appear in constructivist pedagogy, highlighting the difficulties in internalising such an approach. Scott, Mortimer and Aguiar (2006) examine this same tension in terms of classroom interaction. They describe the competing facets of one Brazilian high school science teacher’s role – engaging students with disciplinary ways of thinking yet not ignoring the fundamentally important everyday ideas that children bring. They suggest that science teaching therefore entails balancing both authoritative and dialogic interactions and that the tension between them is an inevitable feature of science classrooms. This tension in constructivist science teaching can also be seen as a paradox of power (Wallace and Louden, 2002); allowing pupils to take responsibility for learning through valuable learning experiences which include having the freedom to express and pursue their own ideas, yet feeling the need to control for the sake of coverage and accountability.

Brodie (2010) describes the issue as managing the tension between respecting learners’ current knowledge and maintaining the integrity of the content knowledge. Within the context of mathematics teaching she discusses the teachers’ dilemma of balancing the desire to encourage learners’ participation and expression of ideas with the requirement to cover curriculum content and shape the direction of learning. She highlights the situated nature of the dilemma but suggests that working with constructivist pedagogy is associated with needing to grapple with such demands. Focussing on the social constructivist context of group discussion in elementary science, Osborne (1997, p.194) explores a further challenge; the ‘unresolvable dilemma’ of using such pedagogical approaches – balancing the group and the individual; encouraging children to interact freely and contribute their ideas in groups, such that exposure to others’ thinking may prompt them to modify their own, yet still
maintain control over groups’ focus; knowing when to intervene and also how to yoke the group work to the critical community of the whole class (Howe and Abedin, 2013).

2.2.3. Using scientific inquiry – a constructivist approach

One of the most compelling and enduring ways of developing children’s scientific ideas, skills and literacy is through the use of inquiry-based approaches (Alake-Tuenter et al, 2012, Harlen and Allende, 2009). Viewed as more than just practical work, experiment or process skill there is widespread support for its use in the classroom (Barrow, 2006, Duschl, 2004). It is widely accepted as a more powerful pedagogic tool than the rote learning of concepts or traditional teaching of facts (Artigue et al, 2012, Kim et al, 2012) and in addition it has been found to enhance interest in science as a curriculum subject (Jocz, Zhai and Tan, 2014).

Dewey (1910, p.127) promoted the idea that science education should be driven by inquiry, discussing it as a way of knowing - a part of human culture through which children could make sense of first hand experiences for themselves and actively create knowledge - and he contrasted this with the many classrooms which were ‘mills fitted out with information hoppers’. There is no absolute definition of inquiry but it provides a useful label which encompasses a range of ideas about the way scientists reason, think and study the world in order to develop understandings (Anderson, 2007). It is generally seen to involve children in asking and answering questions and through this process developing skills such as making predictions, planning and carrying out investigations, gathering and interpreting data, discussing and explaining results, drawing reasoned conclusions, making explanations and communicating findings (Alake-Tuenter et al, 2012, Chinn and Malhotra, 2002, Harlen, 2013); inquiry is complex and this list is perhaps even rather simplistic (Grandy and Duschl, 2007).

Bevins and Price (2016) point to a criticism with the use of inquiry in classrooms - that it can often become a mechanistic progression through the steps, and from their review of school inquiry activity Chinn and Malhotra (2002) call for more authentic tasks which include features such as evidence evaluation rather than depending on oversimplified hands-on activity. Some studies have found that primary teachers tend to prioritise the question asking, planning and data collection stages - suggesting that
this is because these aspects motivate and engage pupils - and place less emphasis on the later sense making stages (Forbes, Biggers and Zangori, 2013, Ødegaard et al, 2014). It has been found in the context of secondary science classes that these latter stages promote productive talk (Hogan, 1999, Lubben et al, 2010) and in the same broad context, Christodoulou and Osborne (2014) highlight the impact of a teacher prompting pupils to evaluate, compare and justify and in doing so promote higher level epistemic discourse. In her review of the body of research into small group interactions Howe (2014) points out that during procedural discussions, such as those around practical investigation work, the exchange of contrasting ideas is less beneficial for conceptual mastery.

Taking an inquiry-based approach provides consistency with what is known about how children learn (Anderson, 2007) and inquiry learning and constructivism are often conflated into a single view of science education (Bevins and Price, 2016). A broad constructivist framework for learning through inquiry is represented in Figure 2-3 and Herrenkohl et al (1999) point out that from a Vygotskian perspective, inquiry can be viewed as a cultural psychological tool for supporting learning because it presents a useful way of thinking. If such activity occurs in a context of collaboration then the relevance of inquiry in a study of peer group talk is clear yet using inquiry-based learning is a complex act and the classroom orchestration of it is challenging and time consuming (Biggers and Forbes, 2012, Davis, Petish and Smithey, 2006).

Figure 2-3 A constructivist framework for learning through inquiry (Artigue et al, 2012)
Classroom inquiry in science can involve children in dialogue with one another as children share observations, try out thinking, come up with answers, provide justifications and express their conclusions. Osborne et al. (2003) suggest that such collaborative activity in the classroom offers a useful perspective on science as a social activity. Lemke (1990, p.1) reminds us of the social practice of science - that ‘learning science means learning to talk science...learning to communicate in the language of science...observing, describing, comparing, classifying, analysing, discussing, hypothesising, theorising, questioning, challenging...’. Varelas et al. (2008) found during their study of U.S. elementary classrooms that creating opportunities for open inquiry facilitated reasoned talk, rich with explanation. Gillies (2013) demonstrated the types of high order and productive talk which can emerge when Australian primary aged children engage in scientific inquiry and U.K. studies have shown how engagement in the discourse of inquiry in primary science has cognitive benefits (Howe et al., 2000, Mercer et al., 2004). It seems clear that there are links between the process of inquiry in science and the use of language for learning and Haneda and Wells (2010) describe inquiry-based science as an effective impetus for the development of thinking through pupil interaction.

Inquiry, being the dominant mode of knowledge construction within the discipline, is central to scientific activity and so if children are engaged in the process of systematic examination of evidence and discussion with others in order to construct understandings of the world for themselves then this can lead to them developing more sophisticated understandings about the nature of science as a shared intellectual endeavour (Grandy and Duschl, 2007); inquiry and nature of science are interdependent constructs (Bartos and Lederman, 2014). Inquiry approaches hold the potential, not just for children to develop understanding of content and processes but also begin to realise that problems are solved through the interrogation of ideas and experience, discussion and creative thinking (Gillies, 2013); learning the nature of science occurs through immersion in a culture where such aspects of science are valued and highlighted (Duschl, 2004). However, the use of inquiry is not a panacea; not all science involves inquiry - other strategies are also required (Harlen, 2009) and its use does not always lead children to develop the accepted ways of thinking (Asoko,
2002, Driver, 1994). Hodson (2014) echoes these points and whilst he agrees that inquiry is an effective learning tool, he argues for a considered approach, where teachers match learning intentions with appropriate opportunities. Broadly classifying classroom activity as either having a goal of learning science, learning about science or doing science he stresses the futility of having a ‘one size fits all’ inquiry strategy.

Hodson’s critique of inquiry approaches stems from what has been described as a long-standing and fairly fundamental dilemma; balancing the differing learning aims between the teaching of the prescribed scientific concepts with the development of scientific inquiry skills (Ovens, 2002). Golding (2013) considers this in terms of tension for inquiry learning. He discusses how teachers using inquiry approaches in subjects such as science face an ongoing balancing act of enabling students to inquire (which he sees as open, dialogic, collaborative work where children make connections and create understandings) and enabling students to get to the knowledge required. He suggests that teachers can find themselves teaching in the face of this tension by swinging between extremes of control and abandonment of learners, like a pedagogical pendulum. Teachers may ‘stage-manage’ the discovery of an accepted body of knowledge, by students who, doubtless realise that the teacher already knows the ideas anyway (Millar and Wynne, 1988, p.396) or to put it another way, 'how to get the pupils to learn for themselves what has been planned for them in advance' (Edwards and Mercer, 1987, p.130). There are however a range of types and levels of inquiry to engage children with in the classroom (Banchi and Bell, 2008, Goldsworthy, Watson and Wood-Robinson, 2000, Windschitl, 2003) of which the confirmation of knowledge level is only one from which a teacher can select (Banchi and Bell, 2008) and therefore what is crucial is making a distinction between inquiry as a learning aim and inquiry as a learning tool (Ryder, 2011).

2.2.4. Using scientific inquiry – the relevance of teachers’ epistemologies

An international report (Harlen and Allende, 2009) which prioritises and highlights the benefits of inquiry-based approaches for the improvement of science education, also focusses on the challenges it brings for teachers, for example the requirement to
adopt specific roles, beliefs and practices and frame pupils as independent learners. In his synthesis of research around inquiry teaching Anderson (2002) underlines that teachers face dilemmas, those rooted in their internal beliefs about teaching, learners and science itself. Alake-Tuenter et al (2012) in their review of the international literature on inquiry-based learning found that using the approach often involved expanding one’s ideas and beliefs about science teaching and learning and in a study of high school teachers, beliefs about science and science teaching were found to be critical factors for the classroom application of inquiry techniques (Crawford, 2007). In addition, in a study of the beliefs of 173 Ecuadorian primary school teachers, Lucero, Valcke and Schellens (2013) found that negative contextual beliefs about the possibilities of science inquiry lead to teachers controlling and tightly structuring opportunities, keeping pupils from open inquiry. Further to this in order to develop authentic inquiry practices it is thought to be important for teachers to begin to view science as a process of thinking and working (Lena, 2011). Following these themes Kumpulainen and Lipponen (2010) demonstrate how a teacher taking a dialogic inquiry approach in his elementary school classroom, including in science classes, supported the agency and active engagement of pupils but firstly needed to frame his pupils as authors of their own learning.

It seems from this literature that although inquiry is often presented as the answer to school science learning it is in fact more complex in its foundation and application. Much of the professional literature for teachers surrounding inquiry recommends discussion as a way forward with this challenging pedagogy; however the interconnectedness of these two practices is less clear. It has been suggested that more research is needed on how teachers use the opportunities stemming from the enabling pedagogy of scientific inquiry to engage children in reasoned talk to make meaning (Varelas et al, 2008). Children’s learning through talk is the subject of this next section which builds on the constructivist theoretical position outlined in the first part of this review.
2.3. Social constructivist classroom action

Based upon the focus of this study - classroom peer group talk - I now move to consider the social constructivist perspective on learning, firstly outlining the significance of the cultural setting. I then explore the role of language in cognitive development and teachers scaffolding action in the context of peer groups before considering Exploratory Talk as a specific form of productive group dialogue.

This research study takes a socio-cultural perspective where the development of thinking is seen to emerge through socially and culturally mediated activity and experience, influenced by a shared history. The pupil is not seen to simply acquire knowledge but is a subjective learner, who arrives with past experiences and prior understandings, diffused with cultural factors, and attempts active construction of an objective reality, by making sense of experiences and reshaping understandings to gain a new perspective on the world. The Vygotskian socio-cultural approach makes visible the presence and influence of culture in the classroom, raising its profile from that of simply ‘content of the curriculum external to the process of learning’ (Kozulin, 2004, p.3).

This perspective is just one of a range from which it is possible to view group collaborative activity (Slavin, 2015) but in using it, the learning context is viewed as a culture in which members are immersed and learn to function. The socio-cultural approach takes account of the fact that humans are social beings; communication and interaction are seen as vital to learning as children construct understandings in collaboration with others. Bruner (1983, p.18) discusses children engaging in joint action through the use of language in group discussion tasks and suggests that using language is a way to make meaning and ‘get things done’ effectively. However, he emphasises that language can only be understood when viewed through its cultural setting. Competence in language can only be realised through culture, as it is this that allows for expression of competence. Here we see no small measure of importance placed upon viewing, not just the language in action and the conceptual development that can be achieved with it but also the culture in which it is enabled to thrive.
2.3.1. The classroom as a culture

Being part of a culture is part of what it is to be human – a natural need and function (Trevarthen, 1995). Cultures are seen to be pivotal in shaping the way we live and learn. Each classroom in which teachers teach and pupils learn can be seen as a unique culture, co-constructed by teachers and pupils, creating an environment for education which is shaped by shared beliefs, rules and activities (Staub, 2007), some of which may be taken for granted, others more visible and explicitly pronounced. This cultural model of the classroom and smaller groups within it even, can be seen as a map (Gee and Green, 1998); a set of shared thoughts and customs which guides members’ actions within the social group. Bruner (1986) suggests that a culture is a place for negotiating and renegotiating meanings; a place where learners are participants, acting together as a culture to co-construct knowledge through their language in use (Putney and Frank, 2008). However, not only is it a place where meanings are changing as pupils learn but the model itself can be modified, expanded across time and events; it is flexible, dynamic and adapts to new landscapes, to alterations in both governing and social structures. Cultural routines, language, patterns of behaviour and identities are established and reconstructed (Wertsch and Tulviste, 1998) as members interact and react with one another (Gee and Green, 1998, Kantor, Elgas and Fernie, 1993); in fact culture comes into existence through social processes (Wertsch and Tulviste, 1998).

2.3.2. The role of language in the development of thinking

As has been previously highlighted, constructivist approaches to learning are embedded in primary science pedagogy. From a Piagetian perspective on constructivism, children’s intellectual development is seen as a universal stage-like process, with individual competency emerging when spontaneous thinking adjusts itself towards more abstract ideas through interaction with environments and although social processes between peers are acknowledged, language is not seen as central to individual sense making (Donaldson, 1987, Wood, 1998). Vygotsky also analysed the origins of cognitive developmental processes and saw children as able to shape their understandings by forging links between their prior experiences and new
encounters but crucially he saw them as able to socially construct knowledge and meanings of their world. This led to his critique of Piaget’s ideas in relation to the lack of acknowledgment of the socialisation process in the development of thinking. From Vygotsky’s theoretical perspective, adults have a key role to play in children’s conceptual development; they supply word meanings around which children can develop more complex generalised thinking constrained by the linguistic milieu; more able others enable children to develop reasoned, systematic and structured ways of thinking and therefore move from the more simplistic organisation of experiences towards the mastery of abstraction. In this way, words direct and guide the process of development and ‘verbal communication becomes a powerful factor in the development of the child’s concepts’ (Vygotsky, 1986, p.123).

In his influential theoretical writing, Sutton (2005) also emphasises the role of language in the generation and growth of mental models. He suggests that learners use language in the process of meaning making, that as they begin to see a scientific concept with ‘new eyes’, they try out new ways of describing and explaining; in short, sense making occurs through language as learners talk around their current mental model and how new evidence fits with it. Groups can develop shared meanings together through talk and as ideas become accepted they become more definite.

The use of language when participating in dialogue with another manifests thinking, indeed is the process of thinking as genuine abstract concepts are meanings embodied in words (Vygotsky, 1978, 1986). In fact, as discussed by Wertsch and Tulviste (1998), Vygotsky argued that a primary function of speech is as a social semiotic; language communicates with and influences other individuals. It is clear that language is prioritised from this perspective and is viewed as a cultural and psychological tool which mediates and shapes the development of thinking and allows for an active role for learners (Alexander, 2008a). This has led to criticisms that language is over emphasised but despite this, Vygotsky’s work has had huge influence over psychology and pedagogy over the last thirty years (Wertsch and Tulviste, 1998).
2.3.3. Joint action through dialogue in peer groups

Vygotsky (1978) prioritised ‘intermental’ functioning, mental processes occurring between people, for example dyads or small groups. He viewed individual or ‘intramental’ mental processes as emerging only through the mastery of social processes. This means that, for a child, the formulation of concepts occurs first on the social level and therefore, the development of ideas is linked to their relationship and interaction with others. It is only later that the child may demonstrate the ability to master and use the concept at an individual level. The emphasis on the socially shared experience, leads to the assumption that individual cognition is a function of interaction.

This theoretical concept can be applied to pupils working in a group. In this context, children listen, hear a range of perspectives, select appropriate information, ask questions and challenge, explain and justify their ideas, interpret each other’s contributions and formulate responses. It is these behaviours which enable them to develop their thinking (Gillies, 2013, Mercer, 1996, Webb and Mastergeorge, 2003). Joint meaning can be created and recreated as children construct their understandings socially, through discussion. As ideas are constructed they are internalised, becoming part of and transforming the cognitive schema for that individual, a process requiring ‘significant mental work on the part of the learner’ (Cazden, 2001, p.77). Of course this can then result in the ability to more clearly explicate understandings, drawing upon previous experiences and an iterative process of interaction between intermental and intramental develops. Discourse and joint action builds up a body of common knowledge (Edwards and Mercer, 1987) upon which further understandings can be constructed. Knowledge then can be seen as a personal construction, socially constructed and validated (Driver et al, 1994), emerging through joint activity (Cole, 1996, Pelech and Pieper, 2010) and learning can be seen as mediated by the socio-cultural setting of the activity (Daniels, 2001).

For researchers, taking a socio-cultural perspective foregrounds the processes of learning and leads to an analytical approach which recognises the importance of the intermental plane (Scott, 1998); for teachers, what social constructivism expresses is
that it is the quality of educational dialogue, not just intrinsic capability, which plays a central role in pupils’ successful learning, (Rojas-Drummond and Mercer, 2003); that interaction between learners can be a powerful pedagogic device (Christie et al, 2009) and therefore engaging pupils in activity which involves dialogue is beneficial for the development of learning (Mercer and Littleton, 2007). Language does not merely transmit pieces of static information; through language there is interthinking (Littleton and Mercer, 2013).

From a sociocultural perspective therefore, it is clear that language use influences both collective and individual thinking. This process can be achieved through the use of cultural tools such as texts but the dynamic experience of peer group talk is a rich arena for the joint construction of knowledge. It follows that peer group work which is organised so that children can engage in purposeful dialogue and discussion is a vital part of an effective learning environment for science.

2.3.4. Teachers scaffolding pupil talk
The gap between what learners can do alone and what they can do with help is referred to as the zone of proximal development (ZPD) (Vygotsky, 1978) and it has been proposed that it is when a pupil works on the edge of this zone that learning occurs. The role of the adult or the more able peer is to scaffold the learning, to provide guidance and lend a structure to the learning tasks and activities (Bruner, 1985). In this way pupils are exposed to increasingly more complex understandings and activities than they are capable of alone (Gauvain, 1995) and stretched to the edge of the zone. The term ‘scaffolding’ first coined by Wood, Bruner and Ross (1976) has been used to describe the way teachers support pupils without taking over responsibility for the learning (Mercer and Fisher, 1992), graduate the level of support over time, diagnose current understandings and adapt teaching accordingly (van der Pol et al, 2014) and provide help that reduces the scope for failure (Maybin, Mercer and Stierer, 1992) thus enabling learning which is ahead of development (Vygotsky, 1978). From their review of literature, van der Pol et al (2010) identify a further range of strategies which teachers use in order to scaffold their pupils’ learning and Rojas-
Drummond et al’s (2013) notion of dialogic scaffolding highlights the importance of sensitive and responsive intervention in group work.

With its emphasis on an asymmetrical context and active role of the teacher or more confident peer guiding a child to deeper levels of understanding than they can achieve on their own, the notion of ZPD is often seen to lack integration with the notion of peer group activity and dialogue. This has implications for viewing group collaboration through a Vygotskian socio-cultural perspective. The makeup of peer group collaborations may not provide all pupils with access to such a person in an ‘instructor’ or ‘expert’ role and pupils can find it difficult to adopt the role of ‘guide’ (Rogoff, 1990). In addition, it cannot be presumed that pupils grouped together will be enabled to learn; not all joint interactions lead to cognitive gain, due to social and communicative differences with the participants (Littleton et al, 2005). An observational study of peer group work in U.S. 6th grade science lessons highlighted the possible interpersonal conflict that the social nature of the group brings as participants negotiate new scientific concepts (Kurth, Anderson and Palincsar, 2002). Therefore theoretically and practically there are difficulties with how the two theoretical ideas integrate; Howe and Abedin (2013) suggest a satisfactory resolution has not been reached.

A reconceptualization of the notion of ZPD has been suggested in order to take account of more symmetrical contexts for learning, such as peer groups where the teacher’s contributions are more variable (Fernandez et al, 2001, Mercer, 2000). Drawing on the ideas of scaffolding and the ZPD, Mercer (2000) proposes the concept of the Intermental Development Zone (IDZ). This concept has been formulated as a means to consider the way in which a teacher and learners can create a shared communicative dialogic space, the IDZ, constructed from their common knowledge and aims. This dynamic shared context created through language supports the mutual orientation of learners as they negotiate their way through activity. If the space can be maintained or adapted through the joint activity it can provide a way for the pupils to operate successfully just beyond their capability and therefore develop new understanding; however, if the dialogue fails to keep the group attuned, the IDZ will collapse. From this perspective the role of the teacher becomes one of developing
IDZs with and among students and ‘setting up a community of inquiry in a classroom in which individual students can take an active, shared and reflective role in the development of their own understanding’ (Mercer, 2000, p.161). The IDZ has been described as both a dialogical phenomenon and a symmetrical group version of the ZPD (Fernandez et al, 2001) representing the way in which a group use language to create a dynamic and contextual basis of shared knowledge and understanding. An interesting and useful metaphor for this concept is a ‘bubble’ of shared consciousness (Littleton and Mercer, 2013, p.110), a shared frame of reference within which a group of learners can travel to new understandings through the invocation of common knowledge and by making reference to common and prior experience (Mercer and Littleton, 2007). The notion of the IDZ focusses on the process of intermental thinking, how teachers and learners use language to build a collective intellectual resource which enables the group to think together, pursue a common goal and make meaning and it forefronts the child as active participant in dynamic dialogic interaction.

What the theoretical frame presented here offers is that the peer group collaborative environment can be seen as a truly valuable and transforming socio-cultural context, a place where pupils can be more symmetrically aligned than in traditional teacher-pupil interactions. It can provide a social context where pupils are positioned as responsible, are given the right and opportunity to make decisions and express opinions and through this process realise collective agency (Arnold and Clarke, 2014). It can be a place where dialogue enables learning through giving and receiving, asking and answering, concluding and reflecting, a place where children make meaning for themselves when they are engaged in structured tasks that require collaboration and higher order thinking skills (Lyle, 1996). During group work, metacognitive talk about thinking is also possible (Tolmie et al, 2010). Teacher scaffolding of peer group interactions must be seen as an important construct in developing children’s understandings in science but it can be viewed as more than just the way teachers question and feedback in dialogic interactions. The role of the teacher is vital in setting up an IDZ but also for creating learning intentions and outcomes, in setting up the group environment (Maybin, Mercer and Stierer, 1992), designing the task (Howe and Tolmie, 2003, Tolmie et al, 1993) and helping students understand the importance of
challenging each other and justifying ideas (Mercer, Wegerif and Dawes, 1999), even if that teacher is subsequently not present to mediate the group discussion with their own talk. Research shows that the role of the teacher in developing productive group dialogue is complex and in her review of a range of empirical evidence Webb (2009) identified four dimensions of the role of the teacher: preparing students to collaborate, forming groups, structuring guided group work and lastly requiring students to engage in certain processes which enable pupils to negotiate tasks, for example inviting pupils to elaborate on their ideas. Tobin and Tippins (1993) suggest that the teacher’s role is to create parameters for activity which bound learners’ thinking such that they are able to construct ideas about a particular concept rather than another.

Through his examination of the role of dialogue in the classroom both for cooperative inquiry and critical argument, Lefstein (2010) discusses how the teacher assumes an epistemological position when taking a dialogic approach, one which acknowledges the importance of openness and questioning. However, he also points to inherent role ambiguity for such teachers, for example attending to social needs may constrain the unpicking of ideas or ensuring the direction of dialogue towards authoritative knowledge held within curriculum goals may stifle the exploration of multiple perspectives. The idealised view of classroom dialogue as being able to smoothly and efficiently scaffold the construction of understanding is therefore in practice full of implicit tension and so, teachers’ thinking and epistemologies also become relevant.

In order to relate the concepts of the overall framework, I suggest that it is through thinking about and structuring the peer discussion task and when balancing social, contextual and historical issues to enable productive talk to occur, including the sharing of and listening to ideas for construction of knowledge (Gillies, 2003), where teachers demonstrate their skill and deliver their expert guidance, scaffolding pupils to new understandings. This structuring, planning and balancing takes place before any group interaction begins but is also a continuous dynamic process of teacher thinking, occurring throughout and between various learning opportunities. Teachers scaffold new understandings, not just through their questioning or provision of relevant, challenging experiences but also through the thought processes that have taken place.
before any classroom activity. Teachers’ knowledge and beliefs, their representations of the reality of teaching to enable productive group dialogue, link to the way they behave in planning and structuring the tasks. Over time, as pupils’ classroom action and attempts at constructing understanding through dialogue feeds back into a teacher’s thinking, that teacher is enabled to think about, structure and plan for further learning. Linking the ideas in this way, it is teachers’ thinking that can be seen as scaffolding the pupils; it is teachers’ ways of thinking that underpin the development of pupils’ scientific understandings.

The theoretical ideas presented so far have shown how the development of understanding can be socially mediated. Based upon this it is clear that small group interactions have great potential for fostering pupils’ learning if the benefits which derive from dialogue can be realised (Christie et al, 2009, Webb, 2009). The quality of dialogue found within groups is therefore of interest to researchers. I will now provide a brief overview of the developing research focus on the practice of using talk for learning before moving on to examine classroom dialogue in more depth and present another key construct for the study; Exploratory Talk.

2.3.5. A research focus on classroom talk

Talk is seen to be the most powerful tool for human learning (Alexander, 2008b); a prerequisite to children’s learning (Swann and Graddol, 1994) and Western pedagogy in particular emphasises the importance of talk seeing it as crucial for effective teaching (Howe and Abedin, 2013). Talk can provide pupils with a ready and flexible tool for working on their understandings (Barnes, 1992); it is easy and impermanent (Barnes, 2010), accessible to many and less intimidating than committing something to paper with writing.

With his statement ‘talk is arguably the true foundation of learning’ Alexander (2008c, p.9) makes the claim for high levels of quality oral interaction in the classroom. The importance of classroom talk has been increasingly highlighted in the last 35 years and an acknowledgement that children learn through talk was a central tenet of the Bullock Report (1975) which stimulated interest in further enquiries in this area. Early
studies gained insights into the dominance of teacher talk by using systematic observation (Flanders, 1970) and others uncovered linguistic characteristics of pupil-teacher dialogue which were previously unseen, for example the ubiquitous initiation-response-feedback (IRF) exchange (Sinclair and Coulthard, 1975). Research studies which observed and analysed the quality of talk and classroom communication began to reveal aspects of talk which contribute to learning and the developmental processes occurring (Barnes, 1976, Barnes and Todd, 1977, Cazden, 1988, Edwards and Mercer, 1987, Wells, 1987). These studies delivered both a better understanding of the role of talk in the process of learning and calls for more interactive approaches to teaching and learning. The work of the National Oracy Project (Norman, 1992), which aimed to prioritise the role of talk in the learning process by enhancing U.K. teacher’s practice and both the primary National Curriculum (DES, 1988, Department for Education, 2014) and the old Primary National Strategy (PNS) (Primary National Strategy and QCA, 2003), where speaking and listening and interactive whole class teaching were given a high profile, led to improvements in teacher knowledge of the importance of quality dialogue although some suggest that the literacy and numeracy standards drive associated with the PNS was counter-productive and reinforced traditional communication patterns (Smith et al, 2004).

There has been much research on classroom talk which focuses on maximising the benefits of classroom dialogue in the context of both teacher-pupil interactions and peer groups (Table 2-1). In these two contexts, the role of the teacher is paramount in engaging and extending the pupil to achieve levels of understanding that they could not achieve on their own.

Teacher-pupil talk is vital in that it can set the groundwork for knowledge development. However, research continues to show that there is unequal distribution of talk between teachers and pupils (Alexander, 2008b, Swann and Graddol, 1994). Teachers control the floor and there is deep retention of the IRF framework and ongoing enactment of what has been called the two thirds rule, where two thirds of talk is done by the teacher and two thirds of that involves asking questions (Flanders, 1970). In addition, within this frame not all pupils are given the same opportunities to
Table 2-1: Brief summary of contexts for classroom talk

<table>
<thead>
<tr>
<th>Teacher-pupil interaction</th>
<th>Pupil-pupil interaction</th>
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<tr>
<td>- The expert guides and scaffolds the cognitive development of the learner, in order that they achieve common knowledge (Edwards and Mercer, 1987). This idea of a guided construction of knowledge (Mercer, 1995) has led to the emerging pedagogy of the spoken word, dialogic teaching (Alexander, 2008a) - using the power of talk to shape children’s thinking as participants take account of each other’s ideas in authentic and extended ways; where the teaching is collective, reciprocal, supportive, cumulative and purposeful (Alexander, 2008c).</td>
<td>- Pupils co-construct knowledge in pairs or groups (e.g. Mercer and Littleton, 2007, Barnes, 2008, Forman and Cazden, 1985). This joint venture, with no teacher expert present to lead, hands control over learning to the children; the responsibility is shifted towards them but also it requires the development of social and communication skills (e.g. Baines, Rubie-Davies and Blatchford, 2009).</td>
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<tr>
<td>- Mortimer and Scott (2003) - Explored the notion of dialogic teaching in secondary science context. Developed a classification system for classroom communication along two dimensions - dialogic (open to students’ ideas)/authoritative</td>
<td>- The development of ground rules with which children are enabled to consider how they can utilise talk for their learning is seen to be vital (e.g. Mercer and Littleton, 2007). These can foster effective language strategies, support groups to critically engage with each other’s ideas and therefore facilitate interaction which promotes high levels of cognitive activity (Baines, Blatchford and Chowne, 2007, Dawes, Mercer and Wegerif, 2000, Mercer, Wegerif and Dawes, 1999, Webb, 2009, Rojas-Drummond and Mercer, 2003, King, 2002). The use of procedural and cognitive guidelines for discussion can raise pupils’ awareness of the power of talk for learning (Herrenkohl et al, 1999) and heighten metacognitive understanding (Schraw, Crippen and Hartley, 2006).</td>
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<td>- Open ended questions to support interaction between pupils are considered to be beneficial (Gillies, 2011, Gillies, 2004, McNeill and Pimentel, 2010). Gillies (2011) found that higher level questioning techniques which required children to</td>
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<tr>
<td>Source</td>
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<td>(focus on scientific knowledge) and interactive/non-interactive. The importance of shifting between categories depending on content and context has been highlighted (Scott and Ametller, 2007).</td>
<td>consider alternative perspectives and make connections between ideas encouraged them to respond with more productive talk in their small groups and use language to reason, justify and explain.</td>
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<tr>
<td>• Chin (2006) - analysis of teacher pupil interaction in Singaporean high schools. Looked specifically at the feedback phase of the IRF exchange, which was found to be of vital importance in helping pupils to develop their thinking.</td>
<td>• Cohen (1994) - teacher interventions into group talk should proceed after careful listening of the discussion in progress and then not with direction but with questioning which attempts to elicit explanations of thinking from pupils. She recognises a teacher’s dilemma when aiming to structure interaction in groups; too much can prevent higher order thinking skills, formats can make the talk itself the centre of learning, leading thinking away from the scientific ideas (Keogh and Naylor, 2007) but too little leads to a concrete mode of interaction and dialogic talk will not take place within the group.</td>
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<tr>
<td>• (Gillies, 2013, Gillies, 2011, Rojas-Drummond et al, 2013) - pupils appropriate effective ways of talking from teachers and independently use them in small groups such that the teachers’ instructional practices scaffold and considerably influence the way that pupils engage with each other in small groups. Clearly the function of teacher-pupil interaction is far more than the transmission of information and checking of understanding.</td>
<td>• Pressing for elaborated explanation (Webb et al, 2014, Newton and Newton, 2000) and reasoned responses (Chinn, O’Donnell and Jinks, 2000) facilitates productive talk. Puppets (Simon et al, 2008) are found to increase the amount of talk, as pupils are more willing to share ideas. Concept Cartoons, which are used to present authentic everyday scientific problems to children, have been successful at engaging pupils in purposeful talk (Keogh and Naylor, 1999) as have Talking Points (Dawes, 2008, Dawes, 2012).</td>
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talk in the classroom perhaps leading some children to develop more understanding than others and ‘one way of trying to overcome that problematical ‘asymmetry’ of interactional power is through peer group talk’ (MacLure, 1994, p.147).

Research suggests that classroom interaction should include a range of approaches and that integrating these two contexts for discourse leads to benefits in the quality and productivity of group talk (Mercer et al, 2004, Rojas-Drummond and Mercer, 2003, Resnick, 2010). Specifically in science there will be times when authoritative, teacher-led talk is important for learning (Mortimer and Scott, 2003) and can be a useful support for pupils’ dialogic interactions (Pimentel and McNeill, 2013). What is necessary is a ‘strategic balance’ (Mercer and Dawes, 2014, p.438), a finding of ‘productive middle ground’ (Michaels, O’Connor and Resnick, 2008, p.291) between times when pupils listen to the authoritative knowledge of the teacher and times when they are given the opportunity to develop their understanding by expressing themselves and hearing fresh perspectives in peer groups (Dawes, 2004). Authoritative dialogue in the classroom alone is not sufficient; children need to engage in dialogue with ideas in order to clarify their thinking and reach an intersubjective position with their teacher but also they need to explore their own perspectives and those of their peers in order to understand how they relate to new ideas presented to them (Wells and Arauz, 2006). It is the peer group context which is under scrutiny in this study, situations where children are invited to share their thoughtfulness. Pupil-pupil talk is:

...probably the most important kind of discussion for all, for here, children are free to exchange, with equals, even the most seemingly farfetched or half-formed ideas. And by listening to others’ ideas, they realise that there are different ways of thinking about and explaining things.....their combined thinking has produced something better than any individual’s thinking (Elstgeest, Harlen and Symington, 1985, p.94).

During group talk without an adult, children treat each other as a resource (Barnes and Todd, 1977) make meaning and support each other’s tentativeness, displaying a readiness to learn as they try out ideas to see how they sound (Lyle, 1993). Pupil-pupil talk consolidates understanding and use of vocabulary, requires of children that they
do by themselves, something which has previously needed support (Edwards and Mercer, 1987) and can foster an agentive disposition to learning (Haneda and Wells, 2010). Of course, in taking a focus on small group talk I do not seek to undervalue teacher led dialogue but view the potential of peer groups as a learning space which can help ‘nudge understanding in the desired direction, creating greater receptivity to what teachers say’ (Howe, 2014, p.113).

2.3.6. Characterising classroom talk

In this next section I first briefly consider some theoretical conceptions of dialogue before drawing on studies based in England and the US in order to consider how it may be examined in the classroom.

In everyday terms, dialogue is thought to be a conversation or discussion; a verbal exchange of ideas where more than one voice is heard. However, Alexander (2000) makes the distinction between discussion and dialogue both of which have cognitive potential. He sees discussion as the sharing of ideas possibly to solve problems yet dialogue as the achievement of a common understanding through structured inquiry. Dialogue is more purposeful than conversation, more complex than using communication skills (Alexander, 2008b). It is important to consider what is meant by dialogue if we are to fully understand its presence in the classroom and how it can be drawn upon for the construction of understanding. Wegerif (2008) highlights that the Vygotskian perspective on learning is not in fact grounded in dialogism but in dialectics where opposing perspectives and competing understandings are required to further reasoned inquiry and mediate learning. This brings a critical edge to knowledge construction as participants in dialogue evaluate conflicting viewpoints, spot inconsistencies and develop a synthesis. Such a dialectical perspective has been contrasted to Bakhtin’s notion of dialogic (Wegerif, 2008, Wolfe and Alexander, 2008) which forefronts multiplicity, seeing participants actively and openly engaging with unique and differing perspectives, interpreting each other’s ideas and considering how these connect with and weave into their own. Through this continuous, reciprocal process of sense making, other’s voices are appropriated in a cumulation of meaning within the context of the dialogue. Both of these types of exchange are integral to the
development of thinking and Alexander (2008b) proposes that his notion of a dialogic classroom draws on a coalescence of both ideas and what is vital is a teacher developing a pedagogical repertoire such that both are incorporated, a point with which Cazden (2001) agrees.

2.3.6.1. Exploratory Talk - one type of classroom dialogue
In his discussion of classroom talk Barnes (1992, 1976) characterises speech as having two functions: speech as communication and speech as reflection. The reflective process involves learners in sorting out their ideas, organising and clarifying with others, going back over an experience and representing it to themselves. The process leads to learners having to make their ideas explicit and clear through explanations and through such talk an individual can reshape their ideas (Barnes, 2010). He stresses that while both forms of using speech are clearly vital in the classroom, unless there is a focus on the reflective talk, children do not have the opportunity to work on their understanding. He also made the distinction between presentational talk and exploratory talk, the latter being the talk that is typical between children as they test out ideas, hypothesise and question; it is hesitant and incomplete; talk through which pupils manipulate what is already available to them and construct meanings from it. Exploratory talk is therefore a desirable, dialogic discourse where pupils critically engage with each other’s ideas, reason and justify through their collaborative group work; the reasoning is visible in the talk and the critical engagement with ideas is a constructive process (Mercer, 1995). Within their influential work Barnes and Todd (1977, p.36) suggest that children shaping their own understanding through talk, using moves such as elicitation, extension and qualification of one another’s ideas, ‘contrasts sharply with any schooling which reduces the learner to a receiver of authoritative knowledge’.

Mercer (1995) drew on Barnes’ ideas in his studies of classroom communication where crucially he found that talk being used as a tool for thinking does not occur frequently; more often heard is talk which is ‘disputational’ or ‘cumulative’. Disputational talk is where participants hold their own position, defending it against other’s ideas to the detriment of the group; talk characterised by short assertions and disagreement.
Cumulative talk is that which is positive in nature but uncritical of contributions, where participants appear happy to accept all offers of ideas so that the group remains stable. This type of talk is characterised by assertions, repetitions and confirmations. These two talk types do not hold the potential for learning to develop because there is no constructive dialogue held within them. Mercer (2000) characterised Exploratory Talk as a typification of how language can be effectively used to think together, defining it as talk:

... in which partners engage critically but constructively with each other’s ideas. Relevant information is offered for joint consideration. Proposals may be challenged and counter challenged but if so reasons and alternatives are offered. Agreement is sought as a basis for joint progress. Knowledge is made publicly accountable and reasoning is visible through the talk (Mercer, 2000, p.153).

These three talk types identified by Mercer and described as ‘three distinctive social modes of thinking’ (Mercer, 1996, p.369) provide a useful analytical tool with which to explore the ways peer groups dialogue with each other and how academically productive such interactions are.

**Table 2-2: examples of linguistic features typical of Exploratory Talk**

<table>
<thead>
<tr>
<th>• Assertions of knowledge</th>
<th>• Elaboration</th>
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<td>• Confirmation of another’s ideas</td>
<td>• Contrasting idea given/challenge</td>
</tr>
<tr>
<td>• Questions</td>
<td>• Hypothesising</td>
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<tr>
<td>• Explanation – procedural/conceptual</td>
<td>• Consensus</td>
</tr>
<tr>
<td>• Recount of another’s idea/repetition</td>
<td>• Scientific vocabulary</td>
</tr>
<tr>
<td>• Reformulation of another’s idea</td>
<td>• Request for clarification</td>
</tr>
<tr>
<td>• Clarification</td>
<td>• Justification of idea</td>
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</tbody>
</table>

It can be assumed that the use of linguistic features which may typify Exploratory Talk (Table 2-2) can be taken as an indicator that high quality, productive learning dialogue is occurring, incorporating both conflict and open sharing of ideas (Mercer, 1996), where pupils are engaging in a process of shared inquiry through dialogue (Wegerif, 2008); talk which includes such features should be encouraged, even required (Mercer et al, 2004). Exploratory Talk represents an educated discourse; using it is working
with the language of reason, the language of the cultural and social practice of science (Mercer, Wegerif and Dawes, 1999). Using Exploratory Talk brings reasoning to the foreground and it has been found that establishing its use in peer group situations has a positive effect on individual reasoning and learning outcomes in primary science (Mercer et al, 2004). It is this type of talk that has been found more in small groups than in whole class situations (Meyer and Woodruff, 1997). Results from studies show that it is an effective way for pupils to construct new shared understandings in the classroom (Mercer et al, 2004, Wegerif, Mercer and Dawes, 1999) and the use of Exploratory Talk is seen to typify interaction within which an IDZ has been created and maintained (Mercer and Littleton, 2007). Fernandez et al (2001) demonstrated how a group of peers working together using Exploratory Talk worked within such a zone.

Findings from one study (Mercer, Wegerif and Dawes, 1999) found more Exploratory Talk was heard in the classroom when children were specifically taught how to use language to reason. Explicit ground rules for dialogue were developed in this intervention study which seemed to highlight the benefit of teaching children how to talk constructively together. The Thinking Together programme (Dawes, Mercer and Wegerif, 2000) developed this idea, emphasising for teachers that part of setting up a dialogic classroom culture where children are adequately prepared to jointly engage in the desirable Exploratory Talk is the setting up of rules for talk. Examples of ground rules are ‘listen to one another’; ‘ask questions’; ‘give a reason’ and it has been suggested that these serve to open up a dialogic space (Wegerif, 2008) such that the group becomes aware of the intersubjectivity of their dialogue and maintain an open and critically constructive stance.

As part of the Thinking Together programme Mercer et al (2004) explored a connection between engaging pupils in certain kinds of talk and the development of scientific understanding. The intervention study involved teacher training in the basis of ideas behind the programme and the provision of lesson plans which included both teacher-led and group discussion activities. Guidance through the application of ground rules was provided to pupils in how to use Exploratory Talk in group situations to enquire, share and reason. Children were asked to work together to solve problems before and after the intervention and an individual reasoning test was also provided as
a pre- and post-test so that individual thinking could be related to the group thinking. It was hoped that these data would reveal changes in the way children talk together and therefore the effectiveness of the intervention programme in increasing the amount of Exploratory Talk used by groups could be assessed. The study concluded that inducting children into the use of certain forms of talk not only enabled them to use language more effectively as a reasoning device to construct new scientific understandings with others but also that individuals became more successful with individual reasoning test problems, supporting the Vygotskian idea of individual learning occurring through a process of social interaction.

The content of talk is important, not just its form; talk needs to have purpose; ideas need to be built upon, not simply exchanged (Alexander, 2008c, p.52). Therefore, talk in science can be seen to be productive when children are grappling with scientific ideas and searching for a more coherent meaning than they already have (Solomon, 1993). Exploratory Talk is therefore a key concept for this study because it provides a focus on the quality of talk occurring.

In addition to this research work in England, in the United States Resnick and colleagues also identified a type of discussion which enables pupils to think effectively together using reasoned dialogue. They labelled this Accountable Talk (Resnick, 1999). The teacher education programme which has been developed from their research, invites teachers to orchestrate talk based activity and encourage pupils to develop understanding of the norms and skills of talking in groups. Accountable Talk is that in which pupils listen to one another’s contributions, question and challenge each other, build on and refine ideas and use reasoning and justification to develop their understanding, which is contrasted with the simplistic and academically unproductive sharing of ideas. Similarly, Littleton and Mercer (2013, p.98) suggest that simply identifying participants in dialogue as a source of useful ideas and framing dialogue as merely a space to appropriate others’ ways of thinking is a ‘weak claim for the influence of joint activity on individual thinking’. Scott et al (2010) have also highlighted the dangers of teachers simply providing space for pupils to share ideas. They point out that just collecting different perspectives together is not enough; the teachers’ responsibility is to also make scientific points of view plausible to pupils.
The use of Accountable Talk in content focussed peer group discussion is seen to be an important feature of classrooms which aim to provide cognitive challenge for pupils and its use has been evaluated using an experimental methodology with findings showing that the incorporation of such talk into classroom processes, delivers positive learning outcomes. As such, parallels are clear between the features of Accountable Talk and Exploratory Talk. Resnick (2010) discusses the importance of Accountable Talk in a Thinking Curriculum, where outcomes are related to high quality learning processes, not simply acquisition of factual knowledge. However, she also suggests that shifting towards this pedagogical approach brings with it significant challenges for teachers in terms of their subject knowledge and confidence. She highlights the importance of teachers not seeing this pedagogy simply as collaborative activity where students are left alone to discover for themselves but viewing peer group sessions as learning journeys with predefined clear intellectual goals, set by the teacher. Crucially, teacher beliefs are thought to be influential on facilitating classroom practices such as those associated with Accountable Talk and a Thinking Curriculum (Resnick, 2010) and as such are an important consideration for research into how teachers facilitate small group dialogue. I have previously made links between the use of group talk and teacher thinking and this notion will be returned to in later sections. Next, I highlight issues surrounding classroom talk which are seen to require further study.

2.3.7. The issue with talk

What has been established in this chapter so far is that in the teaching of science, classroom talk between peers is of real significance but simply providing time for talk does not mean it will be productive (Alexander, 2008c). The form and content of talk is highly relevant and planning for tasks where Exploratory Talk is supported, enables the potential for learning to be exploited (Alexander, 2008c, Howe, 2014). Paradoxically, despite all of the theoretical and empirical evidence which supports claims that a pupil group context is an ideal place for knowledge construction, research continues to show that it is in fact under exploited by teachers and productive talk rarely occurs (Littleton and Mercer, 2013, Mercer and Howe, 2012, Mercer, 2015).
During in-depth studies of English primary classrooms thirty years ago, it was found that group work was scarcely encouraged, in fact where children sat in groups they often still did not work as a group and work was mainly based around task focused interaction not the discussion of ideas (Galton, Simon and Croll, 1980). More recently it has been suggested that groups are rarely formed upon the basis of teachers’ learning intentions, more on the control of attention and class layout (Baines, Blatchford and Kutnick, 2003, Baines, Blatchford and Chowne, 2007) or for management of practical activity (Howe, 2014). Other studies have found that talk is not always productive and useful and that high order group talk infrequent, (Galton and Williamson, 1992, King, 2008) or that little support is given to pupils to make their talk effective (Kutnick, Blatchford and Baines, 2002), indeed group work itself is still a neglected art in schools (Galton and Hargreaves, 2009). Reasons for this are perhaps that teachers tend to dominate classroom talk (Alexander, 2008c, Cazden, 2001), rely on traditional transmissive approaches (Mercer, Wegerif and Dawes, 1999) or carefully manage sequences of talk such that correct answers are achieved and curriculum objectives seemingly met (Myhill and Warren, 2005); it is also suggested that teachers can make assumptions about pupils’ understanding of what is required when they are asked to talk together (Mercer and Howe, 2012). The dominance of teacher led talk is particularly an issue in science classrooms where the focus of activity often centres on the collection of facts and teachers find it challenging to move to more dialogic interaction (Driver, Newton and Osborne, 2000, Lemke, 1990, Pimentel and McNeill, 2013). Research also suggests that teachers’ focus on the social aspects of group work, such as positive collaboration and engagement (Alexander, 2008c) which are of course pre-requisites for positive learning experiences and outcomes and their importance must not be ignored (Lefstein, 2010). However gaining a strong understanding of the purpose and cognitive potential of group talk is important if the role of the teacher in the process of its facilitation is to be maximised (Gillies, 2011).

Alexander also points out that in England we require our children to write more than talk and that teachers and pupils often see this as the real work, the valued product through which we make assessments of progress. Teachers have few strategies at their disposal to maximise the power of talk, despite their enthusiasm (Bennett et al,
2010, Mercer, Dawes and Kleine Staarman, 2009), there is a lack of understanding of how it works (Mercer, Dawes and Kleine Staarman, 2009, Solomon, 1998, Sutherland, 2006) and a reluctance to allow children more ownership (Myhill and Warren, 2005); access to a wider discourse repertoire is seen to be important (Newton and Newton, 2000). There is much complexity and uncertainty with the implementation of dialogic approaches in practice (Reznitskaya et al, 2009) particularly in relation to teaching science where the teaching of the subject’s established authoritative body of knowledge in dialogic ways has been described as pedagogy’s greatest challenge (Michaels, O’Connor and Resnick, 2008). Therefore, further research is needed which addresses the problem of how and when talk flourishes (Wolfe and Alexander, 2008) and also how teachers may facilitate productive talk, scaffold and guide group work, and encourage reflection on learning (Baines, Blatchford and Chowne, 2007, Bennett et al, 2010, Howe et al, 2007).

The strong empirical research evidence which exists in support of the place of group dialogue in the classroom comes from a range of intervention research programmes. Examples are Mercer and his colleagues who have developed the Thinking Together programme, mentioned previously, which aims to prepare pupils for collaborative dialogue by developing their awareness of the importance of engaging constructively in Exploratory Talk (e.g. Dawes, 2004, Mercer and Littleton, 2007, Rojas-Drummond and Mercer, 2003) and in addition, in Australia, Gillies (2011) has conducted a number of intervention studies through which teachers taught children to use effective discourse patterns in their group work. The preparation of pupils for collaborative dialogue was also a focus of the SPRinG programme (e.g. Baines, Blatchford and Chowne, 2007, Christie et al, 2009) which focussed on children developing a range of social and communication skills based on trust and reciprocity in order to work effectively in groups and achieve improved learning outcomes. Other recent projects include Braund and Leigh (2013), Bianchi and Booth (2014) and also Hennessy, Mercer and Warwick (2011) who worked with teachers during an applied intervention study using video data from lessons, workshops, diaries and interviews to develop theory using insights from practitioners. Reznitskaya et al (2009) conducted their intervention study to explore the benefits of a collaborative reasoning approach and in their
recommendations they proposed an important focus for ongoing research is the exploration of the challenges faced by practicing teachers in using dialogic pedagogies during day to day classroom life, a call echoed by Howe (2014).

My study presents such a focus on the routine practices of teachers in order to understand how they utilise group talk in primary science classrooms. The study is also informed by other recommendations in the literature. The importance of the idea of ‘cumulation’ in both handling classroom talk and researching has been highlighted (Alexander, 2008c). It has also been suggested that analysis of snapshots and one off conversations are limited and that by using a temporal analysis, it is possible to look at how joint construction of understanding occurs through time, as participants draw upon shared history (Mercer, 2008). Given the range of research evidence which shows the benefits of group interaction, the vital role of the teacher in encouraging effective talk yet also how productive peer group dialogue rarely occurs, an important consideration may be how teachers think about peer group talk in science and this theme is the subject of the following section.

2.4. **Teacher thinking**

Within the focus of my study, behind the successful planning and organisation of productive peer group dialogic interaction which enables the construction of scientific understandings, lays teacher thinking, seen as the psychological context of teaching (Clarke and Peterson, 1986). Teacher thinking is interactive, reflective, analytical and often tacit; it involves decision making, planning and is underpinned by a rich source of knowledge and beliefs. Teacher thinking shapes pedagogy; values shape practice and give it purpose. An exploration of teacher thinking moves forward from a superficial cause and effect examination of teacher action on pupil learning to research which tries to ‘understand and interpret ways in which teachers make sense of, adjust to and create the educational environment within their schools and classroom’ (Pope, 1993, p.22); put simply it makes sense to study teacher thinking because of its reciprocity with practice (Van Driel, Berry and Meirink, 2014). Simple description of useful teaching and learning strategies for emulation by others in the classroom, does not necessarily lead to effective practice because of the contextualised and complex
nature of the act of teaching. However, understanding the thought processes that contribute to the design and implementation of a learning opportunity are more enlightening; understandings of how teachers manage the complexity and go about their work effectively. It is then that insights may be transferred to fresh classroom contexts with clear understandings of the processes hidden beneath. Taking an emphasis on teacher thinking for this study focuses on understanding the complex process of teaching in action during which teachers make myriad decisions supported by their complex knowledge system.

Teacher knowledge has a range of origins and is complex and multi-dimensional with a range of interrelated systems of understandings, conceptions and orientations, comprising a kind of intellectual biography (Shulman, 1986). One teacher’s practice was explored by Elbaz (1983) in order to discover the nature and structure of teachers’ practical knowledge. Through her study, she mapped out the valuable, contextualised knowledge resource which teachers draw upon in the classroom which included knowledge of self, the teaching situation, subject, curriculum and instructional methods. She also identified personal perspectives or constructs; ways of thinking which implicitly shape knowledge and she highlighted the importance of seeking out such perspectives as a way of understanding the practice of teaching. Van Driel, Beijaard and Verloop (2001, p.141) define teachers’ practical knowledge as an ‘integrated set of knowledge, conceptions, beliefs and values’ and assert that it guides classroom action and comes about through developing teaching experience. They state that practical knowledge which is often tacit is at the core of professionalism and it can change over time and with experience. In line with Elbaz, they also suggest that beliefs play an important part in a model of practical knowledge where they act as a filter through which new practical knowledge is interpreted and integrated. Cooper and McIntyre (1996) suggest a model of craft knowledge, seeing it as tacit and developed from experience but also different to the knowledge gained from theory or ideals.

Shulman (1986) provided a detailed analysis of teacher knowledge, demonstrating how knowledge of the context and content knowledge are essential components. This included curriculum knowledge and subject matter but also what he called
pedagogical content knowledge (PCK), which is the knowledge of how to make a subject comprehensible to others. PCK is seen to be a special kind of professional understanding which teachers develop when teaching a subject such as in this case, science (Fleer, 2009); an integration of instructional strategies, student conceptions and difficulties and subject representation all of which are content specific. Teacher knowledge is ‘a complex system of connections actively constructed from within’ (Barth, 2000, p.190); it cannot be transmitted but is an integration of experiences into personal mental constructs. The active intersection between differing aspects of professional knowledge give it life (Banks et al, 2004) and at the heart of this knowledge base it has been proposed that teachers hold orientations or sets of beliefs; personal ways of viewing science and science teaching which act as filter for knowledge to pass through (Friedrichsen, Driel and Abell, 2011, Magnusson, Krajcik and Borko, 1999).

Research suggests that knowledge and belief are different yet interwoven systems within teacher thinking (Calderhead, 1996, van Driel, Beijaard and Verloop, 2001). Pinpointing how these systems vary is difficult (Anderson, 2015, Clandinin and Connelly, 1987) and there is endless debate about the nature of the difference (Jones and Leagon, 2014). Knowledge is seen to be based upon justifiable, supportable claims but beliefs are what is thought to be true (Hofer and Pintrich, 1997). Nespor (1987) proposes that belief systems have a stronger affective component than knowledge, which is underpinned more by cognition and that in many cases they are more influential (Jones and Leagon, 2014). Beliefs, ‘the piebald form of knowledge’ at the heart of teaching (Kagan, 1992, p.85) therefore have the potential to provide strong insights into how teachers conduct their classroom practice and are worthy of study. In the next section, I unpack aspects of teacher belief and then move on to specifically consider epistemological beliefs about science teaching and learning and the use of talk in science.

2.4.1. Teacher beliefs
Teacher belief is a theoretical construct upon which I am drawing to frame the study. Through my exploration of teacher beliefs the aim is to develop an understanding of
how teachers make sense of their pedagogical practice, specifically to understand the relationship between expressed beliefs about the teaching and learning of science and the way in which participants facilitate productive group talk; examining beliefs provides insight into the learning experiences teachers provide for students (Jones and Leagon, 2014, Simmons et al., 1999). Crucially, research has found that beliefs influence teachers’ interpretation of experience and classroom action, help define ideals and goals for which to strive and mediate both decision making and the application of knowledge into practice (Brickhouse, 1990, Clarke and Peterson, 1986, Kagan, 1992, Lengnink and Prediger, 2003, Nespor, 1987, Pajares, 1992, Rokeach, 1968). Put simply research evidence shows that beliefs can have an impact upon teaching practices in science and the quality of science learning in the classroom (Brickhouse, 1990, Bryan and Atwater, 2002, Fang, 1996, Jones and Carter, 2009). Teacher beliefs are unconsciously held distillations of prior cultural experience which may serve to frame new situations (Kagan, 1992, Nespor, 1987, Phipps and Borg, 2009) and should certainly not be ignored in educational research (Clarke and Peterson, 1986).

Belief as a construct is difficult to both define and study and many see it steeped in mystery, perhaps more suited to philosophical or spiritual realms of study (Pajares, 1992). Studies which aim to explore beliefs tend to employ a wide range of definitions and frameworks and utilise a bewildering array of terminology (Clandinin and Connelly, 1987) for example implicit theories, constructs, beliefs, philosophies understandings, orientations, propositions or perspectives and as such the messy nature of the construct has been highlighted (Pajares, 1992). Bryan and Atwater (2002) attempt a synthesis with a definition:

...beliefs are part of a group of constructs that describe the structure and content of a person’s thinking that are presumed to drive his/her actions (Bryan and Atwater, 2002, p.823).

Beliefs seemingly provide meaning for action and are part of the identity of an individual. It has been acknowledged that if teachers’ beliefs are inconsistent with the philosophical underpinnings of suggested teaching approaches then their effective implementation is hindered (Bryan, 2003, King, Shumow and Lietz, 2001, Pajares,
because the beliefs they hold shape the way they interpret curriculum (Jones and Leagon, 2014). In the context of this study, the assumption was made that through an exploration of a teacher’s thinking it could be possible to develop understandings about their ways of acting when planning for and facilitating productive group talk in science. However, a review of the literature shows that the picture is more complex than that. As Mansour (2009, 2013) points out, there is evidence that teachers’ beliefs do not necessarily have a direct causal impact upon practice and that socio-cultural contexts within which the beliefs are situated also have a role to play. The complexity of school and classroom life may constrain teachers in following their beliefs and this can produce contextualised inconsistencies between beliefs and practice due to constraining factors such as school management decisions and classroom factors, resources, time and learner behaviour (Abd-El-Khalick and Lederman, 2000, Fang, 1996, Jones and Carter, 2009, Phipps and Borg, 2009). Indeed, we know little about the complex relationship between belief and practice (Mansour, 2013). In addition, belief systems are particularly entangled such that teachers can hold dualistic, competing belief sets which create tensions for them in enacting their vision of effective practice (Bryan, 2003, Wallace and Kang, 2004). Instructional approaches taken by teachers have been found to be as a result of interplay of beliefs and context (Jones and Carter, 2009).

Kelly (1955) focussed on belief and formulated a theory of personal constructs in order to attempt to understand why an individual acts in a certain way. Ultimately, because personal constructs about events affect a person’s behaviour, in order to discover and understand that individual’s actions, their constructs must be uncovered: ‘If we reach an understanding of how a person behaves, we discover it in the manner in which he represents his circumstances to himself’ (Kelly, 1955, p.16). A person’s construct is their way of viewing the world; they enable an individual to make sense of their environment and experiences. Kelly saw ‘man as scientist’ with a desire to control events. He conceptualised individuals making decisions about their activity or behaviour by making predictions based on personal constructs. The link between personal constructs and activity is clearly marked; thinking occurs through a structured network of constructs that ‘both facilitates and restricts a person’s range of action’
Within this theory, constructs are seen to be dichotomous, to sit in tension with one another. This theory, which concerns itself with describing and understanding how individuals organise their world, has been highlighted as relevant to the constructivist view of education (Denicolo and Pope, 2001) that has been explored in this framework. It has been used to underpin research in a variety of educational contexts (Jones and Connolly, 2001, Kurz, Batarelo and Middleton, 2009, Lengnink and Prediger, 2003, Shapiro, 1996). It is useful in its application to this research because it takes account of the dynamic nature of teacher’s thinking and allows the teacher’s beliefs regarding the use of talk in science to be explored and described.

2.4.1.1. Eliciting beliefs
Finding a way to make explicit an individual’s belief system is important in order to have an understanding of the way they are planning and acting, although the tacit and complex nature of beliefs makes this a difficult undertaking. A range of approaches may be used to make beliefs visible (Clarke and Peterson, 1986, Richardson, 1996) including the use of experimental or written tasks but interview type methods are very often used to elicit teacher beliefs (Luft and Roehrig, 2007). However, it has been noted that observing classroom practice alongside this process goes some way towards understanding the complexities of how beliefs can impact action (Wallace and Kang, 2004, Wallace and Priestley, 2011) and therefore this study was carried out in relation to and within the participant’s own school and classroom. Pajares (1992) and Richardson (1996) both suggest collecting multiple forms of data in order to understand beliefs and Clandinin and Connelly (1987) propose, that because teacher thought is made up of both prior experience and ongoing pedagogical action, using a dual evidential base of thought and action to understand teacher thinking is more effective. For example, in her case study of university teacher beliefs about the use of technology, Steel (2009) used a combination of stimulated recall, concept mapping and interviews to access belief systems and subsequently analysed the data sets using an inductive approach to reveal themes of beliefs and practices. Additionally it has been suggested that qualitative studies conducted over an extended period of time
are more useful than snapshot quantitative measures in understanding the interaction of belief and action (Bryan, 2003, Kagan, 1992, Pajares, 1992).

The Repertory Grid for eliciting beliefs was developed by Kelly (1955) as one way to explore the structure and content of implicit theories (Fransella, Bell and Bannister, 2004). A range of studies have applied a form of this method (Jones and Connolly, 2001, Kington, Reed and Sammons, 2014, Kurz, Batarelo and Middleton, 2009, Lengnink and Prediger, 2003, Mumby, 1984, Shapiro, 1996). In the methodology chapter I will explore how I have drawn upon this approach to document teachers’ ideas about using talk in science. Despite the range of approaches available for eliciting beliefs, Pajares (1992), Clarke and Peterson (1986) and Rokeach (1968) all caution researchers about the process of trying to understand the complexity of belief systems highlighting the methodological difficulty often experienced due to the necessity to infer from what people say and do.

2.4.1.2. Epistemological beliefs about science teaching and learning

I have highlighted earlier the relationship between belief and practice but focusing further, epistemological beliefs are seen to be ‘individuals' beliefs about the nature of knowledge and the processes of knowing’ (Hofer and Pintrich, 1997, p.117) and therefore relate to teachers’ ideas about teaching and learning in science and the nature and origin of scientific knowledge itself and they are seen to have a pivotal role in the interpretation of knowledge (Hashweh, 1996, Pajares, 1992). Prawat (1992) discusses this type of teacher knowledge as being ‘about content’, including assumptions about the origin of knowledge and how it changes within the discipline. Specifically, a teacher will hold beliefs about what is valid knowledge and this may influence what they prioritise for their students to learn and how they provide learning opportunities. From his action research study of primary teachers’ beliefs about science teaching, Waters-Adams (2006, p.937) states that ‘to teach science entails the adoption of an epistemological position towards knowledge, whether it is held tacitly or clearly espoused’; constructivism can be that particular position taken because it can be conceptualised as a set of epistemological beliefs (Tobin and Tippins, 1993).
Interest in exploring teachers’ epistemological beliefs stems from the recognition that one of the most important goals in science education is the development of understanding about the nature of science (Department for Education, 2014, Harlen, 2011, Lederman, 1992). Lederman (1999) states that the epistemological underpinnings of scientific activity are themselves the nature of science; for example although large portions of scientific knowledge are stable, it is ultimately provisional in nature. Teachers hold beliefs about the nature of science which may range from naïve ideas that science is an objective truth to a more sophisticated belief that science is an evolving human construction. There is concern that teachers may hold limited or naive views of the nature of science (Hashweh, 1996, Lederman, 1992) and this is important because a range of studies demonstrate that epistemological beliefs have a shaping effect on teachers’ classroom practice (Hashweh, 1996, Lederman, 1999, Mansour, 2013, Tsai, 2002, Wallace and Kang, 2004, Waters-Adams, 2006); that their beliefs about science are related to their beliefs about teaching and learning science (Tsai, 2002). For example, if a teacher believes that knowledge is an authentic truth to be discovered and views their job as providing an account for pupils of such a truth, they may utilise transmissive pedagogies which aim to provide pupils with the facts and the use of constructivist and dialogic approaches for the development of understanding could be questioned (Prawat, 1992, Scott, Mortimer and Aguiar, 2006, Scott et al, 2010). Teacher beliefs about the nature of science have also been found to influence opportunities for inquiry-based learning (Alake-Tuenter et al, 2012).

However, the picture is not entirely simple. Tobin and McRobbie (1997) found that some sophisticated beliefs about the nature of science were not enacted in the classroom due to the impact of stronger ideas relating to examination requirements and control. In a multiple case study of five Scottish high school teachers’ beliefs on curriculum innovation, Wallace and Priestly (2011) found that only the science teacher held competing belief sets. Despite being positive about engaging pupils in critical thinking this teacher held certain views about science as a body of knowledge to be conveyed to pupils which disrupted her efforts with more innovative approaches. Simmons et al (1999) found that beginning U.S. science teachers who held student centred beliefs often acted in teacher centred ways in the classroom and Kim and Tan...
in their study of Korean pre-service elementary teachers found that a desire for pupils to connect with scientific truths constrained their attempts to develop inquiry practice in their classrooms. Tobin and Tippins (1993) also acknowledge that belief sets related to control and constraint can create inconsistency for teachers between constructivist beliefs and their classroom action. This literature lends support to the notion that epistemological beliefs impact upon the success of less traditional approaches to teaching and learning but also highlight the importance of understanding the internal contradictions that science teachers often have to resolve in their practice (Kim and Tan, 2011).

The importance of teachers developing sophisticated epistemological beliefs about the nature of science which enable the implementation of inquiry-based learning has been highlighted (Abd-El-Khalick and Lederman, 2000, Kim and Tan, 2011). In an effort to understand the epistemological beliefs related to science teaching and learning there have been efforts to create typologies. Calderhead (1996) created categories for teacher beliefs about teaching and learning: the process of knowledge transmission and the process of guiding learning. Others have used the stranded classification of traditional/constructivist/process (Millar and Driver, 1987, Tsai, 2002). However, Hasweh (1996) through his study of thirty five Palestinian science teachers envisioned a more complex system and created four categories of teacher depending upon their beliefs: learning constructivist, knowledge constructivist, learning empiricist and knowledge empiricist. He found that epistemological beliefs about science teaching and learning have an impact upon the practice of science teachers and that expressed epistemological beliefs were consistent with preferred ways of working, in other words having constructivist beliefs leads to constructivist ways of working. Having empiricist approaches led to less effective science teaching and learning. This fits with what other research evidence suggests; that traditional approaches which place the learner as passive receivers of an accepted body of public knowledge have serious weaknesses (Millar, Leach and Osborne, 2000), are uninspiring, ineffectual and alienating (Tobin, Tippins and Gallard, 1994) and have ‘minimal potential for making the links between ideas that underpin meaningful learning’ (Scott et al, 2010, p.301).
Mansour (2013) conducted a multiple case study with the aim of ascertaining the beliefs of Egyptian preparatory school science teachers and how they may correspond to practice. He found that the teachers fell into one of three dominant belief categories, traditional transmission beliefs, constructivist beliefs and combined beliefs and that there were some inconsistencies between expressed beliefs and observed practices. One reason for such inconsistencies was suggested to be the mediating factor of the socio-cultural context.

Luft and Roehrig (2007) developed an open ended Teacher Belief Interview and using the responses taken from over one hundred U.S. secondary science teachers (both pre and in service) they were able to classify belief systems about teaching and learning. They identified five groupings; both the traditional and instructive categories were found to be aligned with teacher centred approaches and beliefs about science as truth, fact and rule. The responsive and reform based categories were connected to child centred approaches and views of science as a dynamic field. They also established a transitional category.

Using the entirely different methodology of longitudinal case study, Bryan (2003) studied one pre-service U.S. elementary teacher in order to understand how beliefs impact upon science teaching. From the data analysis, she also found that the beliefs expressed by the participant through her practice and through interviews and reflections could be categorised. Bryan identified foundational beliefs such as the value and goals of science instruction, the nature of science and control in the science classroom and these beliefs seemed to underpin all other belief systems related to science teaching. Other belief categories were also identified – those related to how children learn science and the role of pupil and teacher in this process. Interestingly, it was found that within these belief categories, the teacher swung between two contradictory nests; one associated with more traditional transmissive approaches and one connected to her vision for practice which drew on constructivist ways of working. Attempts to reconcile these different positions created tension for the participant in her thinking about science teaching and learning but the process caused her to become conscious of her beliefs and where her practice differed from her vision.

Bryan concluded that deep rooted epistemological beliefs which are more traditional
and view science as a truth to be learned can have a constraining effect on teachers’ thinking and their subsequent attempts to practice with constructivist approaches. Her conclusions fit with other research evidence (Brickhouse, 1990).

Friedrichsen, Driel and Abell (2011) from their theoretical analysis and critical review of literature, propose that science teacher orientations are interrelated sets of beliefs, which can be classified into three dimensions: beliefs about the goals and purposes of science teaching, beliefs about the nature of science, and beliefs about science teaching and learning which include the roles of both pupil and teacher. These orientations are generally in line with those offered by Bryan.

Drawing on data from a combination of qualitative research methods to elicit the beliefs of three New Zealand primary science teachers, Anderson (2015) found that teachers’ beliefs were contextualised but in all cases influenced the science learning opportunities offered. The beliefs most influential were those around the purpose of science education, beliefs about science, about the curriculum and about the students and how they learn. Interestingly, he found that all three teachers’ beliefs about the purpose of science education and about what they learn were more powerful than beliefs about how pupils learn. This study lends support to an argument that the enactment of dialogic approaches in classrooms will be controlled by other more powerful teacher beliefs.

Clearly differing methodologies have been applied within the studies just described and many are focussed on secondary teachers not primary. I have selected an inductive analytical approach for my study and therefore I have not used a typology such as those described above, through which to interpret the thinking of the participants. However, together the studies provide an insight into the beliefs teachers of science may hold and provide an overarching framework for considering teacher beliefs.

2.4.1.3. Beliefs related to using talk in science

Engaging pupils in discussion is essential for developing views of science as a social practice which involves collaboration, argumentation and communication (Duschl,
However, the focus of dialogue often remains teacher-centred (Howe and Abedin, 2013). Although research has focussed on the impact of teacher beliefs about the teaching and learning of science, little research is available which explores beliefs about the role of discourse in science (Fisher and Larkin, 2008, Martin and Hand, 2009, Pimentel and McNeill, 2013) and as indicated earlier, beliefs about how children learn may be subservient to other belief clusters (Anderson, 2015). Despite this, teacher beliefs may influence perceptions about the value of peer group talk which in turn impact upon the quality of dialogue (Fisher and Larkin, 2008, Webb, 2009). Therefore implicit ideas about learning science and how group collaborative dialogue can be situated within that process are an important consideration. Alexander (2000, 2008c) suggests that the over emphasis of thinking about the social functions of group talk found in English classrooms may impede teachers from exploiting its potential for co-construction of understanding. The results of a study into the expectations for talk of six English primary school teachers showed similar issues and an underestimation of the potential of group talk to support learning. In this study, Fisher and Larkin (2008) found that teachers’ thinking about talk was focussed on non-linguistic, cultural and social concerns such as politeness, confidence and talking nicely rather than cognitive factors. These expectations were seen to shape classroom interaction opportunities more strongly than pedagogic concerns and in addition teachers showed a lack of understanding of how to specifically plan for the development of talk. Through her study of 75 pre-service primary teachers, Fisher (2011) examined the issue around why exploratory or dialogic talk is not often heard in English classrooms despite its promotion in literature and through the professional development forum. In line with Mansour (2009), she found that teachers’ prior cultural experiences and negative memories of talk in classrooms influenced their practice of using interactive strategies and how far they felt able to move away from a simplistic and reductive engagement with the approach. These findings seem to highlight the situated and contextualised nature of the issue and the limiting nature of teachers’ socio-cultural expectations for talk.

Pimentel and McNeill (2013) conducted a study of five U.S. secondary science teachers’ beliefs within the context of a professional development programme. They
focussed on factors that may influence instructional methods for whole class discussion and found that teachers held beliefs about themselves, their students and the amount of time available for talk which constrained their practice. Although the research did not seek the students’ views directly, it was found that teachers held perceived student factors such as science talk experience, content knowledge and motivation and that these had a negative impact upon the use of interactive discussion. They identified two beliefs about purposes for science talk: talk for meaning making and talk for content assessment. Whilst teachers appeared to value talk for meaning making, other beliefs about how efficiently productive it could be meant that there was a dominance of dissemination type interactions in lessons. It seems from this study that beliefs about the priority of assessment and accountability in U.S. science learning have a constraining influence over beliefs about dialogic interaction. Howe and Abedin (2013) reviewed a wide range of studies focussing on classroom talk and also concluded that teachers often find it difficult to foster Exploratory Talk because of the tension that emerges when they believe in the value of providing opportunities for freedom to talk in small groups yet are required to ensure curriculum coverage. This tension parallels that which emerged in the literature reviewed earlier, surrounding constructivist approaches to learning science and it surfaces again in a study of one U.S. high school science teacher’s beliefs about student questions. In this study on classroom interaction, Rop (2002) considers the tension experienced through the encouragement of such contributions as he works to balance curriculum coverage, the control of events and teaching efficiency with the desire to encourage the spirit of inquiry.

What the literature seems to point towards is a pedagogical dilemma for teachers wishing to follow their beliefs and engage pupils in dialogic activity for the construction of understanding in science. Much research on beliefs is conducted with secondary science teachers; less with primary and little refers specifically to beliefs about talk. For example, in their interesting description of four effective Australian primary science teachers’ classroom practice and accompanying exploration of the entwined nature of beliefs and action, Fitzgerald, Dawson and Hackling (2013) highlight the way that beliefs seem to evolve in relation to the context within which
teachers work. A wide range of beliefs were elicited yet there was very little mention of beliefs about the use of talk and none concerning pupil to pupil talk. Despite primary teachers generally holding more pupil centred perspectives (Anderson, 2015) research suggests that they also encounter the significant dilemma of utilising dialogic approaches in science, as has been explored in this and earlier sections. Therefore, developing further understandings of the nature of teacher beliefs about using talk in science and how they influence practice will inform the literature and the development of knowledge which exists in the area of primary science teaching.

2.4.1.4. Shifting beliefs

Beliefs or construct systems are in a state of flux; tested and adapted, challenged or confirmed with each experience (Kelly, 1955). However others suggest that teacher beliefs are likely to be static (Bryan and Atwater, 2002) but may shift or become more generalised (Kagan, 1992); although it has been proposed that this process is not based upon reason, more on a gestalt shift (Nespor, 1987). Literature suggests that beliefs can impact upon practice. However, Richardson (1996) points out that beliefs can themselves be influenced when teachers reflect upon their experience and practice and this can in turn enable them to move toward more constructivist approaches to teaching and learning. The mutability of belief has also been highlighted by Avraamidou (2013) in her case study of two pre-service primary teachers responding to and reflecting on their training experience. Waters-Adams’ (2006) study of four English primary school teachers also supports this point. He documented the development of teacher beliefs about science and science education and though the tacit and espoused belief systems of the teachers were initially found to be in conflict, after the action research project, they became more congruent which led them to be more confident science teachers. Using written artefacts from thirteen pre service teachers, Pilitis and Duncan (2012) captured and characterised shifts along the teacher-child centred belief continuum during a U.S. science teacher preparation course focussed on inquiry. They found that teachers moved towards child centred orientations but that the progress was not linear or consistent and sometimes included periods of regression, which indicated that multiple beliefs were interacting
at any one point. Whilst their case study of an elementary teacher working to develop classroom argumentation practices focused more on practice rather than belief, Martin and Hand (2009) also document shifts away from teacher centered approaches. They found that although this took a long time, around eighteen months, pedagogical orientations changed and that more dialogical interactions led to greater student voice and a handover in ownership of learning. Campbell et al (2014) focused on changes in U.S. preservice science teachers’ beliefs over time within the three dimensions of belief identified by Friedrichsen, Driel and Abell (2011). They found from analysing the learning journals of the twelve participants before and after a year of professional development that beliefs shifted away from a transmission view of science teaching and learning and naive beliefs about the nature of science.

Of course the production of knowledge in projects such as those described is highly contextualised and not generalisable. However, the empirical evidence is interesting because it suggests that the relationship between belief and practice is not simply one way but that there is a more complex, symbiotic interdependence between belief and practice. Guskey (1986, 2002) suggested a model for teacher change based upon a range of empirical research evidence. Although simple, this model offers an ordered framework through which to understand the process of teacher change and crucially, it places a change in teacher belief as deriving from the observation of positive pupil learning outcomes, either cognitive or affective. In their study of the impact of professional development sessions on teachers’ use of dialogic assessment strategies in science, Keogh, Naylor and Turner (2011) also identified pupils’ positive responses to practice as crucial for the shift of teacher beliefs and commitment to innovation. Wallace and Priestly (2011) found teacher beliefs changed not as a linear result of professional development activity but as part of an iterative, cyclical process also involving practice and experience. From their wide ranging review of literature on professional learning Opfer and Pedder (2011) concur, highlighting that change in belief is reciprocal with change in practice, that change can begin at any point and that effective teacher learning occurs through engagement in personal daily school-based practice.
Shapiro (1996) used a case study methodology involving survey, interview and repertory grid data and students’ writing to explore the nature of changes to pre-service elementary school teachers’ thinking about inquiry-based science teaching and learning. She used independently completed repertory grids and subsequent interviews with twenty one participants and was able to identify twelve themes of change in thinking about the nature of investigation in science. The participants were provided with a set of elements and were required to rate them against provided constructs when completing the repertory grid pre and post training experience. The elements and constructs had been created from the responses and experiences of a pilot group of students. The change themes were used as a coding structure to apply to transcript data so that themed categories could be created and then reports were written to provide detail about the nature of some significant changes in thinking which had occurred. Shapiro’s notion of change themes has been applied to this study as an analytical tool because it lends itself to the inductive processes being used; change themes emerge from data rather than a classification system imposed onto it.

Studies show that changes in beliefs may occur but that this happens slowly and it has been suggested that more than a year is needed to uncover enduring modification (Bryan, 2003, Martin and Hand, 2009). Campbell et al (2014) discuss how relatively little is known about how teachers’ beliefs can be affected and points out the importance of understanding more about how this occurs.

### 2.4.2. Teacher reflective thinking

Reflective thinking is well established as a tool for exploring and developing practice; a way to use post active thoughts to learn from experience (Clarke and Peterson, 1986); a way to create meaning, explore possibilities and develop as a teaching professional (Brookfield, 1995, Zeichner and Liston, 1996). It is a complex and sophisticated process which has the potential to become part of the dynamics of teaching (Black and Plowright, 2010). There is no precise definition of reflective practice and reflection can be conceived in a range of ways from analysis and evaluation, to professional growth through examination of values and beliefs or as heightening awareness of social justice issues (Calderhead, 1993). Reflective practice enables a deep and thorough
examination of what went right or wrong, involves the querying of situations, feelings and understandings and acts as a bridge over boundaries to new ideas, providing clarification of thinking and professional role (Bolton, 2001). This kind of mindful practice offers a practitioner a way to ‘keep breathing’ within their work (Nugent et al, 2011, p.11) and some have described it as a metacognitive and intellectual process which promotes personal discussion of beliefs and understandings providing teachers with autonomy in the search for deeper understandings of practice (Kraft, 2002, Lin et al, 2013, Sellars, 2014).

Dewey (1909, p.6) is attributed with the idea of reflective thinking, describing it as ‘active, persistent and careful consideration’. This reflective operation, initiated by a perplexity or hesitation can help an individual find their way through uncertainty and mental unrest to some satisfactory conclusion. Dewey’s conception of reflective thinking can be conceptualised as a sustained process of critical inquiry and provides a scientific, rational perspective which sees an individual step back, methodically analyse a situation and using any data available to support the process, work in a reasoned fashion towards some beneficial cognitive outcome or consequence. It is an obstruction in the path of smooth practice that Dewey (1909, p.5) considers to be the catalyst for reflective thinking; some ambiguity that makes an individual raise their head, survey the situation more widely and scrutinise the ‘nature, conditions and bearings of belief’. Dewey’s ideas paint a strategic, controlled and deliberate portrait of the reflective thinking process as a sustained act of mental activity which enables an individual to go beyond what they already know but as Schon (1983, 1987) later characterised, another kind of reflection can occur which is more reliant on intuition.

Schon (1983, 1987) strongly advocated the importance of reflective thought for professional practice and delineated both reflection-in-action and reflection-on-action. Reflection on action is characterised by a Deweyan look back; a retrospective consideration of experience which is divorced temporally from action however, reflection in action is less easily conceptualised. This second type of reflection involves individuals reacting spontaneously and intelligently to puzzling situations as they occur, such that thinking reshapes ongoing action. It occurs through the noticing of something surprising, perhaps even discomforting and leads to implicit
understandings, which have routinely directed practice, surfacing such that they are made available for critical examination. The fresh cognitive awareness enables the practitioner to pause and make adjustments in the present, make new sense and construct new thinking. It seems that this kind of reflection is different from the scientific, deliberate reflection upon action in that it prioritises tacit experiential knowledge or ‘artful competence’ (Schon, 1983, p.19) over rational justifications in order to formulate a way forwards and exercise judgements. Indeed, Hebert (2015) points out that although both Dewey and Schon propose models of reflection and both refer to them as critical inquiry, they in fact derive from differing epistemological positions and the production of new understandings through reflection occurs via different processes. However, a consistent understanding about the process of reflection is that it involves the self-critical examination of belief systems (Kraft, 2002, Zeichner and Liston, 1996).

Although reflective practice involves looking back, in order for it to be productive it must have implications for future action (Scaife, 2010). Curiously considering an experience, reviewing and explaining it has the potential to empower an individual to find new ways of thinking about future approaches. This process of deconstruction and reconstruction involves raised awareness of an aspect of practice and the ‘shaking up’ of any assumptions that affect it (Fook and Gardner, 2007). Scaife (2010) also promotes an internal reflective conversation, using a structure or framework to organise and facilitate thinking. Whilst this personal, individual dialogue is crucial, sharing thoughts with others could be seen a step further towards raising the level of consciousness of the beliefs that impact practice and developing a deeper understanding of it. In her study with a teacher reflecting on mentoring experiences, Goodfellow (2000) demonstrates how a reflective conversation with a partner allows an individual to revisit incidents and through a process of interpretation gain new insights and Lin et al (2013) found that collaborative reflections were beneficial for the development of teachers’ thinking about scientific inquiry. The externalisation of ideas is a vehicle for both learning from and making sense of teaching experiences but also for moving forwards autonomously. Bruner (1996) detailed externalisation as one of the tenets for professional learning. This involves creating ‘outside us’ records of
mental efforts, through externalised endeavour with dialogue and reflection triggering
the action of making tacit knowledge explicit. He suggests a useful motto; ‘thinking
works its way into its products’; externalising ‘rescues cognitive activity from
implicitness’ (Bruner, 1996, p.23-4) as thoughts and constructs become public,
available to metacognition and further reflection.

Developing a reflective stance to professional practice can be challenging and there is
no straight path to some magic endpoint of best practice (Bolton, 2001). However,
there are many frameworks and scaffolds for reflection which aim to move the
practitioner from description to analysis of events and experiences. Some of these are
based upon critical incidents, some focus on developing a sharp critical stance on
practice and others work an individual through a set of questions which are designed
to probe understandings and to move forward from description, although some staged
models have been criticised for being mere checklists (Black and Plowright, 2010). A
framework comprising categories of teacher knowledge has also been proposed as a
tool for reflection (Banks et al, 2004, Banks, 2008). It was found to enable novice
primary and secondary teachers, in a range of cultural contexts to articulate and
consider aspects of their professional knowledge and develop their reflective practice.
A cyclical process, which is iterative in nature, complements the process of teaching
and learning that is occurring in parallel with the reflection. Kolb’s (1984) discussion of
the theory of Experiential Learning highlights this cyclical nature. Learning is a
continuous, holistic process, grounded in experience and influenced by environment;
the process of learning creates knowledge. His framework provides a model for
thinking about experience, the starting point of which is a descriptive and personal
account of an event in order to prompt reflection. This is followed firstly by an analysis
and evaluation of the experience in terms of personal understandings and then by a
consideration of potential action. Kolb’s ideas about Experiential Learning chime with
Kelly’s (1955) theory which emphasises that beliefs are ever developing and changing
through experience as ‘the manner in which an individual approaches new situations is
mediated by past experiences and reflections; these influence the ways the individual
perceives the world’ (Jones and Connolly, 2001, p.474). Kolb’s theoretical framework
takes account of the idea of teachers’ reflective practice because this kind of
experiential learning and reflection can inform and even perhaps adapt teacher thinking (Vaino, Holbrook and Rannikmae, 2013) and therefore can form part of the overall mechanism for conceptualising the study.

Some criticise particular forms of reflective practice and suggest that it can become yet another process or device to be measured by, a way to convince supervisors of professional competence (Taylor, 2006), that an individual can become too involved in their own story and lack criticality or that any revelation of weakness can be destructive (Hickson, 2011). However, if the emphasis is placed upon valuing artful engagement with the process and an exploration of any newly constructed knowledge then the positive potential of reflection is highlighted. Schon (1983, p.61) discusses reflective thinking as a form of professional knowing which enables a professional to ‘make new sense of situations of uncertainty or uniqueness which he may allow himself to experience’. This can be done by drawing on prior understandings in order to converse and experiment with the situation and it is not too big a step to see how critical reflection in the classroom begins to be teacher research (Kraft, 2002).

Reflection can be viewed as a form of research as it generates professional knowledge. This leads to the development of notions about professionalism to include the idea of teacher as challenger of action and constructor of knowledge through reflective practice and so the teacher can then be seen in the light of teacher as researcher (Day, 2000, Stenhouse, 1975). Stenhouse (1985b, p.15) proposed that curriculum research could and should be undertaken by teachers, as groups or even as individuals because ‘teachers are in charge of classrooms’. He thought that teachers facing the complexity of the classroom and carefully studying their own work would lead to increased understanding of pedagogy and suggested that a conscious study which raises awareness, would lead to improved reliable practice (Stenhouse, 1975). This kind of inside-out research is based in making the tacit, explicit; based on teachers participating in consciousness raising activity. Once the personal knowledge becomes articulated then it can be understood. But this takes time; ‘time is a potent influence suffusing all that takes place’ (Hamilton (1973) cited in Stenhouse, 1975, p.154).
2.4.3. Connecting with pupils’ thinking

Consulting pupils in order to gain their personal perspectives, in this case on the use of peer group talk in science, can illuminate the practice of teaching and learning. This assumption is based upon research literature which highlights that pupils have understandings about how they engage in learning (Cooper and McIntyre, 1996) and have valuable contributions to make to a discussion on school and classroom activity (Pedder and McIntyre, 2004, Rudduck and Flutter, 2000, Rudduck and McIntyre, 2007). Research has also found that pupils have conceptions about their science learning. These range from the memorisation of facts and passing of tests to the development of understanding, application of ideas and gaining of new perspectives (Tsai, 2004). Pupils’ conceptions of learning can have an impact upon their epistemic beliefs about science and their motivation for and engagement with learning tasks (Ho and Liang, 2015, Hofer and Pintrich, 1997). It follows that a consideration of the pupils’ ideas about their science learning should be an important factor in any exploration of the teaching process.

Importantly, teachers have been able to draw on pupil perspectives to enhance learning conditions through processes of trying out new ideas, fine-tuning or tailoring yet this accountability process can be challenging for teachers (McIntyre, Pedder and Rudduck, 2005, Morgan, 2011). There are similarities between the findings of two U.K. studies which both highlight pupils’ desires to have deeper involvement and active engagement in their learning, with opportunities more connected to their own experience and therefore more meaningful (Pedder and McIntyre, 2004, Rudduck and McIntyre, 2007). Pupils articulated an eagerness for autonomy and responsibility – for gaining a sense of ownership and agency in the classroom.

From a sociocultural perspective pupils should not be considered as neutral in classrooms but as participants who bring with them experiences and perceptions which shape their dialogic interactions and for this reason research which incorporates pupil views is valuable. Despite this, studies of classroom interaction usually focus on pupil behaviour (Fisher and Larkin, 2008) with the voice of pupils seldom being heard through research (Niemi et al, 2015, Rop, 2003). Through their recent study of science
activities at the interactive whiteboard in twelve English primary school classrooms. Kershner et al. (2014) did draw on pupil perspectives about group work. They suggest that over time and with experience, children develop their thinking about language use in group work and this can impact upon their success in collaborative learning.

In their English study covering participants aged four to twelve, Fisher and Larkin (2008) explored pupils’ perspectives of talk using interviews and questionnaires. They found that pupils showed real enthusiasm for talk but also revealed an awareness of the constraints of school talk, specifically of the teacher’s power to control it within the classroom environment. Interestingly the children’s perspectives on talk paralleled the teachers in that they focused on non-linguistic and social rather than cognitive factors and even by a young age pupils had developed an impression of the sociocultural expectations of teachers. Overall, pupils were found to have little agency within the context of school talk.

The degree of freedom to explore ideas and practice scientific discourse was questioned by U.S. high school students in an ethnographic study conducted by Rop (2003) who examined student perceptions of their attempts to open up the classroom dialogue. He found that students felt their attempts at independent inquiry were sidelined when they did not match up to the teachers’ intentions. This research provides a different view of the teacher’s dilemma described earlier but from this perspective the story ends with not just efficient curriculum coverage but also feelings of frustration followed by resignation to accepting the traditional discourse pattern. Other research, using video-stimulated interviews to explore pupil perspectives about the use of talk in primary mathematics lessons in England, found that older pupils had a sense that they are able to extend their thinking and develop new ideas from interaction with peers and could therefore perceive this as a means of learning. However, they also had epistemological views which led to a view of the teacher as the ultimate controller and validator of knowledge as truth (Pratt, 2006). Others have found that children value opportunities to work together and solve problems but that within peer groups feel it can be a struggle to challenge each other (Howe and Abedin, 2013), that they value talking over listening (Braund and Leigh, 2013) and that teacher beliefs impact pupils’ perspectives (Fang, 1996, Mansour, 2009). This final point is perhaps supported by...
Kershner et al (2014), described above, who note that children’s perceptions of the benefits and challenges of group work paralleled those of their teachers.

2.5. Conclusion

Through this chapter I have tried to establish a theoretical basis for exploring participant thinking as a way of gaining understandings of orientations and action towards the teaching and learning of science through the use of group talk. What the current research suggests is that classroom action is shaped by complex sociocultural expectations of both teachers and pupils and that there are considerable tensions for all in the enactment of ideological constructivist positions which lie at the heart of dialogic pedagogical approaches, such as the use of peer group discussion.

I have also described the theoretical position that pupils can learn through a process of interaction and shared dialogue, therefore peer group discussion is a valuable resource on which to draw, that it can ‘operate as a mechanism by which learning occurs’ (Howe, 2014, p.112) and the teacher’s scaffolding role is vital in this process. However, research tells us that despite its benefits, peer group talk is not well embedded, that productive episodes such as those demonstrating features of Exploratory Talk are infrequently found and that whilst practitioners are enthusiastic there is a lack of understanding of its cognitive potential. Opportunities for science teaching such as the use of inquiry are well embedded within statutory frameworks however teachers face a range of challenges in delivering the requirements of the primary science curriculum, including tensions in working with constructivist approaches to learning.

Despite the positive impact of a range of intervention studies, understanding both pupil and teacher thinking about talk and how it is routinely used seems to have a role in developing a broader understanding of how to promote the use of classroom practice which involves pupils in discussion, yet the research literature in this area regarding the primary stages of science education is not overflowing. Studies which seek to reveal situated understandings of the tensions inherent in using peer group talk in science would be useful (Lefstein, 2010) and will develop our knowledge of this
part of classroom life. The next chapter provides the methodological detail of my study which aimed to develop such understandings.
3. Methodology
3.1. Introduction

The purpose of the study is to explore and understand the ways in which primary school teachers successfully engage pupils in group talk in science and to shed light on this area of classroom practice by studying teachers’ routine ways of using and facilitating peer group discussion in the classroom. The research design addresses the following question:

How and through what processes do primary school teachers engage pupils in productive group talk in science?

The study was conducted and the research questions explored through an interpretive framework and by employing the qualitative methodology of case study. This chapter provides an account of the methodology, of the way I worked and the decisions I made throughout the research process. I will also explore issues which arose during the study and how I tried to handle the challenges they brought.

Doing this study is about finding out about something new but it’s also about developing a way of working. Learning to be a researcher – this is a messy process!

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3.2. Theoretical backdrop

During the course of my study and the development of the methodology I have developed an understanding that any research project will be grounded in one of many traditions or orientations. I have considered a range of strategies and methods and read many definitions of varying approaches. Studies can be labelled, amongst other things, as qualitative or quantitative, interpretive, naturalistic, phenomenological or observational. This is often confusing and trying to fit my idea for study into a relevant box was tricky, however the designations refer not to overall design but to different parts of the design process (LeCompte, Preissle and Tesch, 1993) and in addition, it is not always useful to draw a false dichotomy between approaches for example, between qualitative and quantitative; benefits of both can be drawn upon when developing a project, selecting the approach which will enable the most effective data to be collected in pursuit of answers to research questions.
I have realised that in order to frame your study, you have to define in your own terms how you see your research and how it aligns itself to established approaches and epistemologies. You cannot jump into a box of ideas set up by someone else and then camp out; you make your own base, set your own boundaries and justify them, based on others’ work. Other research, other people’s definitions and criteria should provide the basis from which to work out your own study. Coming to this conclusion took a long time and was rather frustrating; being from a scientific academic background, where projects and methods fit into a different paradigm, with strictly bounded categories away from which you must not veer, it was a huge intellectual leap and I needed to be aware that ideas from an empiricist ontology and epistemology can persist, despite making a decision to carry out qualitative, interpretive research (Vasilachis de Gialdino, 2009). This struggle was still evident at the outset of the fieldwork:

*I must remember I am not testing anything – the scientist in me I suppose – I have to keep reminding myself that I am not out to prove anything and remember the setup of the study.*

From the outset, thinking carefully through the aims of the research, the questions and the assumptions I made about the context of study enabled me to begin to sift out what was relevant and what was not. I realised that new situations and experiences would shape and form the project and that I needed to be open to this happening, to acknowledge it, discuss it and make it explicit in my work.

3.3. Defining the study

Assumptions of the social world of the classroom and how to gain knowledge of it have implications for the choice of methodology. These assumptions define the way I see the context under study and how I choose to understand it. They lead me towards an overarching paradigm, a framework or cluster of beliefs which influence my research and the manner in which it is undertaken and interpreted. A paradigm can be seen as a disciplinary matrix applied to a study (Taber, 2013, p.288) a set of fundamental notions about the reality to be understood and it forms a theoretical backdrop to the research, defining what is understood by knowledge and knowledge
production. Paradigms co-exist and have differing, attending ontological, epistemological and consequently methodological assumptions which permeate the research process; positivist and interpretive paradigms can be viewed as being at different ends of a continuum and taking one or other of these as the framework for the study has an impact upon the methods used and the answers generated (Thomas, 2009). A constructionist, interpretive paradigm underpins this project and this is visible through the ‘how’ language of the research question.

Aligned with this paradigm is the perspective that the world is different for everyone and experiences carry different meaning for each individual. Viewpoints and practices are different as are the social backgrounds related to them (Flick, 2009); knowledge is socially constructed, held by participants and value laden; it is not simply out there to be objectively collected, tested and verified. By taking an interpretive approach I recognise that the participants’ perspectives captured are their personal understandings (Hammersley, 2008) and I acknowledge that the research process is not a search for the revelation of a single, objective truth. Researcher subjectivity also exists; their mind is not neutral. An interpretivist researcher digests experiences before offering understandings (Hollis, 1994); interpretivist research ‘grasps the subjective meaning of social action’ (Bryman, 2008, p.694). There will always be a position taken, a set of values or an emphasis to be declared (Becker, 1967). Each researcher will ‘pick their way through the fieldwork differently’ (Ball, 1993, p.43) and make different analytical decisions. Consequently they would not present the same account and in this way a researcher becomes an instrument who can illuminate, interpret and make meaning in the research context.

This study is based upon an ontological assumption that the reality of the classroom, its members and small groups, is a social construction with multi layers of interaction and multiple perspectives on any single event. This reality is built by the creative, individual people who inhabit it and interact within it. Being so, each classroom is different because different people co-construct each one, ‘the social reality under investigation is not the same as other social realities since each is constituted by the distinctive interactions, perceptions and interpretations of the members of the social group. Each group will be defined in terms of its own negotiated meaning’ (Pring,
The classroom environment is a culture of rich diversity, constantly shaped by both its social practices and its history and this notion is key in this study of group work and the learning taking place within it.

The epistemological assumption underpinning this study is that this social reality can only be known about through gaining a clear and deep understanding of the unique classroom context. Knowledge about such a distinctive environment can only evolve through gaining insights into the situation and the people acting within it. Actors in the context construct their own understandings and meanings and act upon them accordingly; each individual has their own take on any situation. Knowing about these multi-perspectives within the classroom can only be found through discussion with participants and by seeking to gain an appreciation of their viewpoints and reasons for action; observation alone is not enough; the social world can be ‘understood from within rather than explained from without’ (Hollis, 1994, p.16). Meaning comes from engagement with our world (Crotty, 1998) therefore immersion and partnership throughout the research process are vital for theory building; both observation and interaction are required for uncovering and exploring the knowledge in order to gain understandings about the perspectives of participants, what they think and experience in their own social world.

This study is concerned with how teachers operate, how children’s talk is planned for and guided and how in practice the children are enabled to engage in purposeful talk. The research aims to understand a social and human phenomenon and therefore the inquiry process should build a holistic picture of the studied context, to develop an understanding of the unique classroom and its participants, their views and interpretations. This leads to the choice of a qualitative approach which enables the most effective data to be collected in order to answer the research questions. ‘Qualitative researchers deploy a wide range of interconnected interpretive practices hoping to get to a better understanding of the matter at hand’ (Denzin and Lincoln, 2008b, p.4) and the goal of this study is to do just that; to gain insight into how teachers and pupils make sense of specific learning opportunities and therefore develop a greater knowledge and understanding of the processes which lead to productive group talk in primary science classrooms. The aim is not to collect facts in
order to test or prove theories or count occurrences of events and there is no
universal scientific law to discover. Therefore a positivist, more quantitative approach
is not fit for purpose; it would not lead to suitable answers to the research questions.

The ways in which a researcher creates and drives a study is an expression of
positionality which governs the act of inquiry (Clough and Nutbrown, 2002). Ideas and
assumptions about the nature of knowledge itself are important to acknowledge
because they provide the researcher with a basis for decision making in the
construction of the methodology; in the selection of methods and the shaping of tools.
For example, in trying to answer my research question ‘How and through what
processes do primary school teachers engage pupils in productive group talk in
science?’ I needed to consider how a teacher’s thinking about the use of peer group
discussion could be captured. One option would be through a broad and thorough
one-off interview. Perhaps this would capture the principled knowledge (Shulman,
1986) yet there is knowledge which is more contextually dependent and event
specific. Therefore, would an interview around a lesson be more appropriate? And
then what questions would uncover such thinking? In addition, practitioner knowledge
is perhaps more tacit, expressed at the point of practice (Elbaz, 1983) so would
observation of practice in action provide access? It is clear then that questions of
epistemology – what is knowledge and how we come to know it – underpin the
construction of the methodology.

3.4. The research design
A research design is a strategy for thinking through the research topic (Gibson, 2010)
and it provides a set of guidelines that connect the theoretical backdrop of the study
to the empirical methods (Denzin and Lincoln, 2008a). I think it is useful to see
research design as something which is constructed. This implies that the project is built
to fulfil the purpose of answering the specific research questions and that methods are
considered and either selected or rejected based upon the suitability of the data that
would be produced. The methodology needs to be fit for purpose and appropriate to
the questions posed. In the following sections I will outline the overall framework used
for the study, the potential it held for answering the research questions and also the possible limitations.

3.4.1. Ethnographic backdrop
Initially an ethnographic approach to the study had been decided upon due to its ability to ‘examine the process of teaching and learning, the intended and unintended consequences of observed interaction patterns’ (LeCompte, Preissle and Tesch, 1993, p.28). Ethnography is the study and interpretation of a culture, a discrete location, from first-hand experience (Pole and Morrison, 2003) and its employment implies a focus on the perspectives of those within that culture, the key informants (Burgess, 1985). Having defined the context of study as a unique culture, ethnography seemed appropriate because it encompassed particular features that were central to my work. However, doing ethnography implies that the researcher gains knowledge through close participation in the context, becoming a part of the situation under study in order to gain a holistic overview. An ethnographic tradition essentially involves participant observation, where the researcher not only experiences the culture under study but also interacts naturally within it, developing relationships, becoming immersed and adopting the cultural practices of the setting. This can be associated with the idea of ‘going native’ (Gold, 1958, p.211). By employing this approach I knew that I would need extended periods of time to know the world of each classroom. Having taken on a new professional role, with more responsibility and workload just prior to the field work of the main study, it was time that I did not have available. I could not practically carry through the ‘long immersion’ required (Thomas, 2009, p.119), follow the daily round of life and explore the backstage areas as required by ethnography (Ball, 1985). Hammersley (2006) alerts us to the limiting aspects of such temporal issues when considering ethnography. For me, a lack of time for long observation precluded being able to create the big picture and locate specific observed situations in any wider school context. My focus was a small area of classroom life and so although I could perhaps define the study as a micro-ethnography (Bogdan and Biklen, 2003, Simons, 2009, Hammersley, 2006), I realised that I needed to rethink my position. Whilst aiming to keep in mind the benefits of the
ethnographic tradition of participant observation in a natural setting throughout the design and implementation of the study, I decided to utilise a case study methodology which offers the possibility of a ‘condensed field experience’ (Burgess, 1984, p.2)

3.4.2. Case study approach
I selected the popular qualitative research approach of case study for this inquiry because it aligns with the interpretive perspective taken and because the study of real life classroom contexts deserves an in-depth treatment. The multifaceted nature of a classroom means that a ‘dip in and out’ research technique would not do justice to the subject being studied. My project is a study of a particular aspect of classroom life and the purpose of carrying it out is to generate in-depth understandings. This means that case study is an appropriate methodology because it explores the particular (Stake, 2008) and forces attention on the complexity of the situation (Stake, 1995). Simons’ (2009) definition of case study was particularly helpful when framing the study:

...an in-depth exploration from multiple perspectives of the complexity and uniqueness of a particular project, policy, institution, programme or system in a real life context. It is research-based, inclusive of different methods and is evidence led. The primary purpose is to generate in-depth understanding (Simons, 2009, p.21).

Stake (2008, p.119) notes that the ‘case’ is defined by the focus of interest, that case study is ‘a choice of what is to be studied’. This helps me to define the case under study and place boundaries upon it such that I can state that the case is teachers’ thinking about and use of peer group discussion in primary science across an academic year. Such a statement of the main unit of analysis (Yin, 2014) allows me to focus data collection which is relevant to the phenomenon under study. Leading from this, participants in the study can be viewed as being able to illuminate the case and provide insights from different perspectives enabling me to generate a deep understanding. Therefore, using Yin’s (2014) typology for case study, this project takes a single case study design. However, the choice to observe within the classroom and seek the perspectives of both teachers and pupils produces an embedded, case study design. Contributions from the range of participants create subunits of analyses within
the single case study, which offer ‘significant opportunities for extensive analysis, enhancing the insights into the single case’ (Yin, 2014, p.56).

Case study is a comprehensive strategy, an all-encompassing method (Yin, 2009), is holistic and gives the opportunity to collect data with a range of tools which work together in complementary ways (Stake, 1995, Tellis, 1997). Case study then defines the whole project – not just the fieldwork and uses insight as a basis for understanding, rather than asserting general laws from experimental techniques (Stenhouse, 1975).

Initially, my study used a ‘what’ question – ‘what strategies do teachers use to engage pupils in group talk in science?’ However, Yin discusses the research questions that most suitably fit case study (Yin, 2009) and identifies ‘how’ and ‘why’ as being best addressed by this method. Thinking about this enabled me to further develop my research question into one that gave greater scope for exploratory inquiry into teachers’ practice. The newly articulated question could only be answered with a methodological approach that allows for the complexity of the classroom, differing social interactions between pupils in practice and accepts the changing dynamics of the context; an approach that takes account of the variability of human action and interaction and factors that influence it and represents practice in action. A positivist, experimental approach would have been too coarse to answer the questions this project seeks to engage with, such as ‘What are teachers’ considerations when the talk is most/least successful?’ or ‘In what ways does teacher thinking impact upon their practice of using group discussion?’. Case study reports containing responses to these questions are perhaps of interest to other teachers. Simons (2009) discusses how such reports do allow easy access and can be used as a basis for informed action. Therefore, in order to maximise the benefits of the study and work with the consequences of the study in mind (Stutchbury and Fox, 2009) findings could be made available to a professional audience.

An important feature of the case study approach is that it is iterative in nature and responsive to the issues identified by the participants (Denzin and Lincoln, 2003, Stake, 1975) yet Walker (1986) notes an issue which limits case study; that they can be seen
to be locked in time, whereas the audience moves on. However, the design of this case study does enable it to be flexible, take account of participant views, document and explore change so an audience of practitioners has the potential to relate not only to the context but also to the reflective process. Indeed Stake (1995, p.48) asserts that an important characteristic of case study is that it is emergent, reporting changes in understanding and that it seeks emic issues, the actors’ frames of reference.

There are issues to consider when embarking upon case study, not least the warning that it is difficult (Bassey, 1999). A concern is around the validity of case study as each looks at unique characteristics and the idiosyncratic nature of the observation can lead to concerns about generalisability. Yin (2003, p.10) addresses this with a notion of ‘analytic generalisation’ which centres on expanding theory and (Bassey, 2001, p.17) suggests making ‘fuzzy predictions’, through the extrapolation of findings to similar situations. The philosophical foundations of this interpretive study do not make claims about the generalisability of findings; context is an ‘impediment to generalisation’ (Stenhouse, 1985a, p.265) so perhaps the notion of transferability or relatability (Bassey, 2001) is more relevant here. Pring (2000, p.107) discusses the ‘fallacy of uniqueness’ and how there is always some typical feature to use for drawing parallels which can help with transfer of information to new contexts. The emphasis in this project is on the exploration of teacher thinking around group talk in science and descriptions of findings are potentially valuable for others and transferable to new environments. Here professionals wishing to develop their own practice with peer group dialogue could engage in apparently useful patterns of thinking in order to create their own understandings, indeed teachers should not have to conform to rigid prescriptions (Daniels, 2001) but should be enabled to develop their own action. Clearly describing the context for an audience is therefore important so that a vicarious experience is offered and readers can judge for themselves how relevant the study is to their own setting (Stake, 2008, Stenhouse, 1985a, p.265).

In addition to these points, Stake (2008) reminds us that case study is not about generalisation but about understanding and in this study the aim is to create meaningful and situated understandings of the routine use of peer group talk in
science, drawing on the perspectives and raised awareness of the teachers who act as partners in the research.

3.4.3. Other considerations
Other methodological approaches were considered and action research was carefully examined, due to its affiliation with the powerful idea of teacher as researcher (Stenhouse, 1975). As a partner in the intended project, I can act as teacher researcher. As an experienced practitioner, with knowledge of a range of classroom environments, I am able to be an empathetic researcher, understanding practical difficulties and in this way, the concept of teacher as researcher provides a boundary for the project. However, in action research, the practitioner is central. They are innovator; an implementer of some change which is then carefully documented and this informs future practice; a cycle or spiral of action occurs, which is researched by the teacher. This research strategy for professional development is highly personal; the practitioner should make the decisions on what to change and how to move forward; they are in control. In the role of outsider, I felt I could not impose my ideas for a piece of action research upon another – this would be in sharp contrast to the idea that this methodological approach is a personal and empowering one. McNiff and Whitehead (2011, p.8) comment that ‘action research can be a powerful and liberating form of professional inquiry because it means that practitioners themselves investigate their own practice as they find ways of living more fully in the direction of their educational values. They are not told what to do. They decide for themselves what to do in negotiation with others’.

3.4.4. The pilot phase
I carried out a pilot study in order to test the methods selected for the project (see Appendix 11 p.396 for details of related publication - Hewitt, 2014). This phase of the study took place over four weeks and was set in a Year 4 classroom in mainstream urban school with a socially mixed catchment area. I was familiar with this school as I had previously worked there for a number of years therefore I knew both the children
and staff and this seemed to simplify the process of gaining access. I ensured that this school was not to be a main study site.

The piloting of the study was enlightening in a range of ways connected to the research methods selected. I will not list them here but instead draw out how this phase helped me develop the fieldwork in the research method sections of this chapter.

3.4.5. Main study participants

Within this section I will briefly introduce the schools and participants. The terminology ‘participants’ is perhaps more aligned with the interpretive approach I have taken, rather than drawing on the notion of ‘sample’ which is the language of experimentalist traditions (Thomas, 2009). The project is such that I make no claim for generalisation to a wider population and no claim about the representative nature of the group of participants who informed the study. The participants were recruited using a focussed, purposive method (Scott and Morrison, 2006) where I used informed decisions to look for those who would be propitious participants. An account of the challenging process of recruiting participants is given in Appendix 2.2 p.300. Initial visits were made to meet all the participants (see Figure 3-1).

The fieldwork phase of the main study took place in three different schools in England; all judged as good or outstanding primary schools by the Government’s inspectorate, Ofsted. The proportion of children with English as an additional language was low in each school. The participants were the Year 4 teachers and their class of children, aged 8-9 years old. Within each class a group of pupil participants was selected to be a focus for the data collection and I explore my use of this method later in the chapter. Year 4 was the same year group as used in the pilot phase and it was chosen because children of this age are mature enough to be able to work collaboratively in groups, keeping focussed on a common aim. They have had exposure to the way in which school science works, are unlikely to have become disillusioned (Beggs and Murphy, 2001), have been in school long enough to have developed knowledge of the implicit ground-rules of classroom interaction and have awareness that educational discourse is a
process which embodies questions and both builds and checks understandings. The three teachers who were participants in the study have been named as Emma, Arun and Simon for the purposes of anonymity. All of the three participating teachers expressed their interest and enjoyment in the teaching of science. An overview of the participants is provided in Table 3-1 and pen portraits for the three teachers are presented in Appendix 2.1 p.298.

An ethical issue surrounding gaining access emerged through the process of recruitment of participants. One of the Head Teachers was particularly keen to engage her member of staff in the project. Arun was a relatively new teacher and was to be taking over the role of science coordinator the following year. The Head thought that this project would be useful and of interest to him. However, when I met the teacher for the first time, he seemed less eager than his superior but still engaged with me
politely and asked a lot of pertinent questions about the project. As we chatted further, he began to talk about his hopes for moving the school to an inquiry approach for science but also said that if he was going to do the project he wanted to get something too – that he had made a decision to ‘use’ me to get information for his new role as science coordinator. I initially felt a little shocked but this meeting gave me food for reflection:

_Research Journal June 20th 2012_

I went away with a feeling of dismay - perhaps the Head just wanting something is not the best way to start the project. I hoped the teacher would be interested but perhaps he felt forced into participation as a fairly new member of staff – could he say no?

Issues around consent were emerging and I questioned myself - even though the teacher had said he would take part was he truly assenting? Was the power dynamic between teacher and Head Teacher such that he felt he must consent? It is important for a researcher to be sensitive to the relationship between gatekeeper and participant and not take ‘the gatekeeper’s word as final, especially where the gatekeeper is in a position of considerable power’ (Raffe, Bundell and Bibby, 1989, p.17) and so I needed to be aware that perhaps this teacher was unsure, even insecure. I tried my best to establish rapport as a way to negotiate this additional layer of access (Reeves, 2010) and I tried to talk about the purposes of the study, my hope for partnership between us and draw parallels between his plans for developing science in school and using collaborative group talk. The vaguely uncomfortable nature of this meeting prodded me to think more deeply, less technically (Clayton, 2013) about the ethical issues around consent which are seen to be central to ethical research activity (Burgess, 1989a) and how gaining it is an ongoing process.

Layers of access apparently continue when the pupil participants are considered. I asked the teachers to select the pupils who would be part of the focus group because of their superior knowledge of the individuals. I asked if the group could be mixed in ability and gender and suggested that it would be best if there were no extremes of behaviour to be managed. The teachers responded by considering their class and selecting from the children who had brought in the informed consent forms. In this
way, the teachers acted as gatekeepers to the children whose group talk would be studied in depth and in doing so at the outset, began to shape the data and outcomes (Flewitt, 2005).

Table 3-1: Overview of participants

<table>
<thead>
<tr>
<th>School</th>
<th>Teacher</th>
<th>Class</th>
<th>Pupils (15) in mixed ability focus group</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>Emma - a highly experienced teacher; taught for 17 years, across full primary age range and also abroad Part of senior management of current school Music specialist</td>
<td>Class of 31 Support staff in class on some occasions Large airy classroom with direct access to outdoors. Tables grouped in 4s or 6s. Small library area and range of displays.</td>
<td>Nathan, Sam, Ellie and Yvonne. Sometimes Emma also included Harry and Ali. The group engaged well with each other and worked together regularly. Sam emerged as a dominant character and Yvonne was very quietly spoken and rather shy.</td>
</tr>
<tr>
<td>B</td>
<td>Arun - new to teaching, having only one year’s experience Science Coordinator</td>
<td>Class of 32 One member of support staff in the classroom. Large airy classroom with direct access to outdoors. Tables in rows focused on a carpeted seating area and interactive whiteboard.</td>
<td>Oliver, Nigel, Beth and Lucy A confident group who generally engaged well with their learning At times Beth and Lucy appeared to be dominated by the boys who often took control of resources during practical work.</td>
</tr>
<tr>
<td>C</td>
<td>Simon – experienced, having been teaching for 7 years.</td>
<td>Class of 32 Support staff in class on some occasions. Small classroom with a library corner and a range of displays on wall. Carpeted seating area facing an interactive whiteboard. Tables in groups of 4/6 children.</td>
<td>Ella, Tom, Mark and Andrew. Sometimes Simon included Evan in the group. The boys in the group were friends with each other outside of this context. They worked well together and with Ella. Tom dominated both activity and conversation; Mark was more reserved.</td>
</tr>
</tbody>
</table>
3.4.6. Ensuring quality

When thinking about constructing quality research, notions such as reliability and generalisability emerge. These are concepts from a positivist epistemology which do not sit comfortably within this study. I have considered the issue of generalisability in the earlier Case Study section and as the aim was to produce accounts of complex social situations and events, reliability, which is concerned with repetition, is not suitable here. So, another typology for judging quality is required.

Table 3-2: Reflexive considerations for quality control

<table>
<thead>
<tr>
<th>Questions for reflexive attention to quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Credibility</td>
</tr>
<tr>
<td>Confirmability</td>
</tr>
<tr>
<td>Transferability</td>
</tr>
<tr>
<td>Dependability</td>
</tr>
<tr>
<td>Authenticity</td>
</tr>
<tr>
<td>Relevance</td>
</tr>
<tr>
<td>Transparency</td>
</tr>
</tbody>
</table>
Creating a set of guidelines or considerations, locally to a qualitative research project, and using these to assess quality could be beneficial, alongside developing a practical capacity to make judgements (Hammersley, 2007). I decided to consider my study in terms of its quality by attending to a range of notions (Lincoln and Guba, 1985) summarised in Table 3-2 and then use reflexivity for quality control. With this in mind and as a way to validate the study I posed some questions to myself at the outset of the study. These are presented in Table 3-2 and within the following methods sections, I reflect on the key issues which emerged.

3.4.7. Research methods

The varying methods and instruments employed in the study were used to collect data from three key classroom perspectives; teacher, pupil and researcher. This range of evidence is important for a number of reasons: it places value on the viewpoint of all involved, which is important because it can help to create good working relationships, it aims to give all participants a voice and it also reflects the assumption that the classrooms under study are cultures - places where all the inhabitants have a part in shaping practices. In addition, an important strategy for ensuring the quality and validity of a case study is to use triangulation (Stake, 1995, Yin, 2009) therefore multiple methods of data collection were built into the design in order to seek the perspectives and interpretations of more than one subject and illuminate situations. Surveys and questionnaires were discounted as possible methods because they did not fit with the epistemological foundations of the study and being data gathering tools mainly for creating numbers (Thomas, 2009) they would not provide data which would allow for rich enough answers to research questions. The following sections detail which methods were selected and why. I also consider the impact of the method on the data produced in terms of the benefits they brought and also challenges I faced through employing them. A diagrammatic and tabular representation of the way the methods were employed throughout the fieldwork is given in Figure 3-2 and Table 3-3. These demonstrate how methods came together to form the fieldwork phase and provide an overview of data collection. See Appendix 12 (p. 397) for an overview of timings for the data collected.
Figure 3-2: Overview of research methods

- **Familiarisation visit 1**: Meet Head and Teacher
- **Familiarisation visit 2**: Teacher initial interviews
- **Initial Phase**: Meet pupils

**Iterative Phase**
- Lesson observation
- Audio recording of pupil group talk
- Teacher oral diary entry
- Pupil group interview

**Transcription of pupil group talk and pupil interview sent to participating teacher for reflection. Report of oral diary also sent for comments.**

- **Teacher final interview**
- **Final Phase**

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<table>
<thead>
<tr>
<th>Teacher</th>
<th>No. of Iterations</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emma</td>
<td>8</td>
</tr>
<tr>
<td>Arun</td>
<td>9</td>
</tr>
<tr>
<td>Simon</td>
<td>5</td>
</tr>
</tbody>
</table>
### Table 3-3: Total number of data collection methods used

<table>
<thead>
<tr>
<th>Data Production Methods Overview</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Lesson observations</strong></td>
<td></td>
</tr>
<tr>
<td>(22)</td>
<td></td>
</tr>
<tr>
<td>Emma 8</td>
<td></td>
</tr>
<tr>
<td>Arun 9</td>
<td></td>
</tr>
<tr>
<td>Simon 5</td>
<td></td>
</tr>
<tr>
<td><strong>Peer Group Discussion Recording</strong></td>
<td>(23)</td>
</tr>
<tr>
<td>Emma 9</td>
<td></td>
</tr>
<tr>
<td>Arun 9</td>
<td></td>
</tr>
<tr>
<td>Simon 5</td>
<td></td>
</tr>
<tr>
<td><strong>Teacher interviews</strong></td>
<td></td>
</tr>
<tr>
<td>(12)</td>
<td></td>
</tr>
<tr>
<td>Emma 4</td>
<td></td>
</tr>
<tr>
<td>Arun 4</td>
<td></td>
</tr>
<tr>
<td>Simon 4</td>
<td></td>
</tr>
<tr>
<td><strong>Children’s interviews</strong></td>
<td></td>
</tr>
<tr>
<td>(21)</td>
<td></td>
</tr>
<tr>
<td>Emma’s Group 8</td>
<td></td>
</tr>
<tr>
<td>Arun’s Group 9</td>
<td></td>
</tr>
<tr>
<td>Simon’s Group 4</td>
<td></td>
</tr>
<tr>
<td><strong>Oral diaries</strong></td>
<td></td>
</tr>
<tr>
<td>(22)</td>
<td></td>
</tr>
<tr>
<td>Emma 8</td>
<td></td>
</tr>
<tr>
<td>Arun 9</td>
<td></td>
</tr>
<tr>
<td>Simon 5</td>
<td></td>
</tr>
<tr>
<td><strong>Research journal</strong></td>
<td></td>
</tr>
<tr>
<td>(1)</td>
<td></td>
</tr>
<tr>
<td>35 entries</td>
<td></td>
</tr>
</tbody>
</table>

| Understand the context of learning by being part of it; collect first-hand accounts | Understand how the participants are using talk in practice; systematic analysis possible | Understand perspective of participants through generation of account of their interpretations; interaction provides opportunity for in-depth exploration | Understand perspective of participants through generation of an account of their interpretations; interaction provides opportunity for in-depth exploration | Understand perspective of participants; reflective tool; generate descriptions and interpretations ‘immediately’ after event | Collect my interpretations; reflect upon issues having impact upon research process |

I have not classified the study as an intervention in classroom practice because specific strategies for peer group talk were not recommended to the teachers. They were of course, fully informed about the focus of the study and asked that peer group talk be incorporated during observed science lessons, in line with their routine practices. However, as can be seen from the overview (Figure 3-2) much of the classroom data collected was fed back to the teacher participants. This injection of material for teachers’ ongoing reflection cannot be ignored as teachers had the opportunity to not only reflect upon the experience of a lesson but also look through a researcher’s lens analyse the outcomes using concrete data and in this way perhaps the study could be framed as an intervention.
3.4.7.1. Classroom observation and recording

3.4.7.1.1. Why use observation?
Observations are an important method for a researcher using a case study methodology because they provide new perspectives and an invaluable aid for understanding the case (Stake, 1995, Yin, 2003, p.93). Through its employment in this study observation provided me with the opportunity to gather first hand open-ended written data around the lessons in which the children were being encouraged to talk in small groups. It was a chance to see the teacher and pupils at work, rather than just ask them about it after the fact and also to collect data in the moment, to make an ‘immediate and fresh account’ (Wragg, 2012, p.16) of actual events as they were happening. Being part of the whole lesson, rather than just observing the small peer groups talking out of context, allowed for a more holistic understanding and it also meant that during the post lesson group interviews with children, I was able to have a shared history with the informants, and this could be referred to at points when required.

3.4.7.1.2. Observation details
In total over the course of the fieldwork I observed twenty two lessons – nine with Arun, eight with Emma and five with Simon (see Appendix 8.3 p.340 for an overview). I had planned to observe nine in each classroom but Emma was unable to make one due to some last minute school production rehearsals and I struggled to organise the full quota with Simon. After the second lesson he seemed a little reluctant to continue with the observations and he postponed my visits on a number of occasions. After this, a PGCE student was placed with him which, understandably, became his priority. After the student had finished her placement I contacted Simon and we began to pick up the project again. The fact that there was a break in the observed sessions with Simon’s class is perhaps a threat to validity because of the reduced data available from these participants. However, the study still continued for the same overall time period in Simon’s class, meaning that validating factors associated with long term involvement (Evans, 2013) were still relevant.
The epistemological foundations for the study suggest that interaction within the research setting is important for gaining insight. With this in mind, during the fieldwork I tried to position myself as a participant observer (Ball, 1985, Gold, 1958). Had I placed myself as a somewhat removed, non-participant observer, seated at the back of the classroom to only watch and record may have been interpreted by participants as judgemental. Teacher’s experience of observation is generally in a review or inspection context and so I was aware that if I took the seemingly objective position, it could lead to an imbalance of power and a shallow relationship between researcher and teacher, with attending implications for the authenticity of post-lesson oral diary accounts. I found that achieving a balance between observing and participating during the lesson was a tricky, delicate and complex matter to negotiate.

I felt a tension today with the observations. It would be easy perhaps to sit on the side and take notes but there is a need to take part, to be a part of the classroom in order to develop relationships and understand a little more of what is going on. I try to keep my notes with me and work with the groups so I can watch and listen to what is going on. RESEARCH JOURNAL October 11th, 2012

There is a difficult balance to be struck when observing the group to find out how they are working and also not interfering to affect their behaviour and learning. RESEARCH JOURNAL October 31st, 2012

I had begun to recognise the challenge of trying to be part of the lesson and the classroom, interacting with it whilst it was in action (Delamont, 2012), immersing myself and becoming a part of that culture but also hiding myself away so that the session was as natural as possible. However, as the time progressed I became aware that not only was working flexibility important but also that by being part of the lesson and working with the children I had stumbled across an important way by which I was able to initiate and facilitate the teachers’ reflective oral diaries that followed and I will return to this point within the discussion of that particular method.

3.4.7.1.3. Recording children in the classroom

Throughout the study, during each observed science lesson a focus group of pupils chosen by the teacher were recorded talking in their collaborative group. This group remained almost the same for each class throughout the year. Following the traditions of ethnography, I decided that I needed these peer group discussions to occur in the
natural setting of the classroom. I designed it in this way to ensure the children were at ease and confident with their surroundings and that observations made were as close as they could be to the usual practices, allowing for the fact that a researcher and recording equipment were present. By recording the group’s discussions I was able to capture their talk for analysis and the transcriptions were also sent to the teacher before the next observed lesson so that they could read what the reality of the group’s talk was.

I chose to make audio recordings as evidence of group talk because video recording can be more disruptive to the situation. The natural situation was important to the study and although some would argue that a video recording gives more data and a rounder picture, there is never complete data (Silverman, 2003) and the technical and situational concerns were more pressing than gathering nuance of expression; the focus was strictly on the talk and therefore I decided that an audio recording was sufficient. Initially, during the pilot study, recordings were only made of the group talk. However, for the main study the recorder was left on for the whole lesson. Not only did this seem to reduce the effect of the recorder being present, as nobody was interrupting the flow to switch it on and off, but it also allowed for an accurate review of the teacher talk which occurred before and after group sessions. The natural setting of the whole classroom had implications for the quality of recording; the background noise level made listening to the playback tricky and subsequent transcription was difficult and hugely time consuming. After the first session in the pilot study, where the group talk was almost inaudible through the backdrop of the rest of the class talk, making transcription impossible, two higher quality sound recorders were employed, one at each end of the table. This enabled all of the participants to be heard; gaps from one recording could almost always be filled with the second. During the main study I continued with this approach, with only one slight hitch when somehow the pause button was pressed on one of the recorders during a lesson. The children seemed to become more comfortable with the recorders over time, and Emma’s group spontaneously picked them up and took them outside with them on one occasion. However, one of the children in Simon’s class hinted at some frustration with the presence of the device, grumbling a little that it was ‘getting everything we
say’. I realised this may be a way of showing some lack of assent with being part of the study and I spoke with Simon, asking him to talk to Tom to see if he would like to withdraw but the next time I arrived I was told he was happy to be in the group.

3.4.7.1.4. Making notes

I decided to use unstructured observations to collect data because of their potential to immeasurably strengthen (Delamont, 1976) a methodology which also draws upon other data collection techniques. In this case, the recordings of pupil group talk would have been isolated without the context of such observations. I thought it preferable not to use predefined quantifying coding schedules such as those employed in systematic observation (Croll, 1986) but to let the ‘occasion tell the story’ (Stake, 1995, p.62) and therefore I made notes in an open ended way, which would allow for the more natural emergence of themes and categories through subsequent analysis.

During the lessons I had a field note sheet (Appendix 3.3 p.304) with me to record what I heard and observed, as a low inference narrative (Preissle and LeCompte, 1984). I noted details of practice, descriptive noticings of participant action (Creese et al, 2008) for example teacher’s observable strategies and interventions, the nature of the group work, learning intentions and activities set, resources and settings, details about the ways in which the children were working, the classroom environment and the flow of the lesson and timings. During the pilot phase, the style of these notes changed as I struggled with the competing tasks of being participant in the context yet needing the time to create a useful record of the unfolding, dynamic situation. This concern followed me into the main study:

What if I am collecting the wrong stuff and effectively throwing away good stuff? Research Journal November 12th 2012

This is a problem noted as common (Creswell, 2005, Yin, 2009) and experienced ethnographers advise that when making field notes to accept the ‘more achievable goal of recording phenomena salient to major aspects of the topic’ (Preissle and LeCompte, 1984, p.112) which means that the data collected has been filtered through the gauze of the researcher’s thinking. Eventually I developed a format of loosely structured written commentary on the group work tasks and session as a whole,
focussing on teacher input. This purposeful focus on teacher action for note taking evolved with the realisation that in the first week, I had concentrated observation on the pupils, when actually my research questions required me to explore the teacher. I had made what seemed like a basic error in data collection and I noted to myself that, when in doubt, go back to the question. For the main study this emphasis remained but I did also make notes about the children, generally the focus group. After a few observations I also began to note down details about the learning environment and resources so that I would be able to present fuller descriptions. As soon as I could, I also created a detailed lesson summary (for an example see Appendix 8.2 p.338), using any observation notes and my own interpretive commentary, so that the session could be easily refreshed in my mind during later analysis.

3.4.7.2. Interviews with teachers

3.4.7.2.1. Why use interviews?
In employing interviews as a research method, I have drawn on the project’s epistemological framework which highlights the importance of interaction between researcher and participant in order to gain understandings of the context and the actors’ perspectives. Interviews are widely used data sources which allow a range of issues to be covered; meanings can be constructed from the knowledge gained which are used to examine the research questions posed (Roulston, 2010b).

Put simply, the rationale for selecting interviews as a research tool was that when you ask them questions, people can tell you things as they see them from their perspective; it is an opportunity constructed with the purpose of talking about the focus of the study (Dingwall, 1997). More precisely, interviews have the potential to generate descriptions of events, capture authentic and faithful accounts of the participating teachers’ thinking about their practice of facilitating peer group talk and explore meanings through the words of informers; things that could not be revealed by observational methods alone. There are criticisms which claim that people’s talk does not always accurately represent what they are thinking (Hammersley, 2008, Roulston, 2010a); that individuals can be unreliable narrators, creating recollections
tarnished by emotion or dominated by specific events, that interviews alone are insufficient when studying social contexts and so naturally occurring observational data should therefore also be used (Silverman, 2005, Walford, 2001).

3.4.7.2.2. Interview format

I conducted a pair of interviews, one straight after the other, with each participant during one of the meetings before the classroom observation phase of the study. They were both designed to elicit an account of and to explore the participants’ overarching principles, ways of thinking and classroom practices regarding the use of group talk in science. One of the interviews was semi structured; based around a set of predetermined open questions (Appendix 3.1 p.301) through which I tried to ensure coverage of my research agenda. However, in the introduction to the interview I also tried to ensure that the teacher understood they were free to talk about something else of significance if they wanted to. The interviews generally lasted around half an hour and were recorded and transcribed.

The use of the semi structured approach was a helpful tool in the challenge to ensure the quality of data. Despite it perhaps leading to a more asymmetrical relationship than if I had chosen a completely unstructured approach, I realised it was less likely to lead to free flowing conversation, which was important to avoid on account of its potential to allow my own perspectives to become explicit and could possibly give rise to biased accounts.

The other interview was based on a rep-grid interview technique (Fransella, Bell and Bannister, 2004). For this interview, there were no questions; the teacher was asked to talk in their own words about the way in which they used a range of classroom peer group discussion strategies, the ways in which they had found them successful or useful (or not) and how they were the same as each other or different. This was designed to provide a different way of eliciting teacher thinking about using group talk in science, through a process of elaboration which aimed to bring to a conscious level more tacit thinking and in practice I took a conversational approach. This part of the interview generally took over half an hour.
I provided a large set of cards each labelled with a strategy for engaging pupils in talk (Appendix 3.2 p.303). I asked the participant to select the ones they were familiar with and had used and we discarded the others. I asked the teacher if they wanted to add more to the set by completing a blank card with a further strategy. I then asked the teachers to select three cards from their final set, two of which they thought were similar and the other different. These cards then became the focus of a free-flowing discussion with the teacher being encouraged to talk through their selection and how they used the strategies, why and what they found beneficial about them. I found that this interview situation lent itself to using probing techniques, as discussed earlier:

The interview did feel like a professional discussion – we were talking around the subject and questions evolved naturally in response to the teacher’s thoughts, rather than being pre-planned.

I employed questions such as ‘which is most important then?’ , ‘why do you think these are ones you use the most’, ‘what is it about that one that makes it more successful’ and ‘why is that one different?’ This technique, called laddering in the rep-grid literature (Fransella, Bell and Bannister, 2004) was used to try and dig a little deeper into the teacher’s thinking about their own practice. The interview came to a close naturally when the ideas emerging began to repeat. The conversation was recorded and transcribed and the data produced treated alongside the semi structured interview data in the analytic phase. In addition, as the interview was progressing I made a note of the cards being used and a brief note of my grasp on the points arising from the discussion. I shared this list with each teacher afterwards in an attempt to verify these immediate interpretations with the participant (Kvale, 1996).

Although most often these interviews ran smoothly, one did not go well.

The (card sort) interview was disappointing. I don’t think it went well at all. It was very stilted after the relaxed approach of the other (semi-structured) interview. There was a lack of flow; it seemed to be more difficult. I am not really sure why. Whether it was the change in tempo…it felt forced the whole way through. I felt as if I needed to apologise for it.

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During this card sort interview with Emma I decided to abandon the selection and comparison of three cards for a more simple discussion of the strategies because the interview was becoming difficult. I realised that I needed to be flexible in my approach in order to not have the interview ‘fail’; to ensure that I could collect some useful data.

This pair of interviews was repeated at the close of the study. The final semi structured interview employed a set of pre-determined open questions (Appendix 3.1 p.301), including some used in the initial interview, but there were some differences and additions. It emerged during the ongoing oral diary entries (a method which will be discussed in a later section) that the participants felt they had changed the way they worked to facilitate group talk over the course of the project. I therefore created final interview questions to elicit further ideas about this and to encourage teachers to discuss their conclusions at that moment about productive group talk and how they facilitated it.

3.4.7.2.3. Interview strategies

The perspective taken in this study is that an account elicited from participating teachers is a reconstruction of events or of thinking, that there is no absolute truth to be mined from the participant and that probing strategies can help to capture a rich, substantial and trustworthy account in order to make a claim about the quality of data. In a sense, the interviewer is a traveller alongside the informant as they tell their story (Kvale, 1996). During the interviews I tried to take some opportunities to follow up responses in order to clarify ideas, ask for examples or for the participant to elaborate with further detail. Probing for further explanation from participants is a way of creating a thicker layer of data and therefore developing strengthening internal validity (Evans, 2013). I did find it challenging, especially during initial stages, to move away from the security blanket of the schedule but there are examples of when I employed follow up probing techniques:
Liz: So you value the group discussion because they (pupils) get to share ideas but also get their own independence, is that what you are saying, or... (paused to allow participant to respond further with any clarification)  

Arun Final Interview 1

Liz: okay, if you are saying this is the perfect group discussion, what sort of thing are you listening for, that you can say, yes, that’s productive?  

Arun Final Interview 1

Liz: so in science then are you saying that that makes group talk more challenging or or easier?  

Emma Initial Interview 1

Liz: so is that your way of seeing how they are doing or is that something different?  

Emma Final Interview 1

In addition, examination of the interview transcripts shows that at times, I also used ‘okay’ or ‘right’ (Simon Final Interview 1) with a pause afterwards as some sort of signal or active silence (Cameron, 2005) to invite the participant to carry on if they could. These kind of strategies, alongside the fact that I developed a set of questions around my specific research interests, meant that I had influence over the process of data generation and that the act of interviewing was a co-production of knowledge (Hobson and Townsend, 2010) or collective assembly (Silverman, 2005).

As previously mentioned, there is the possibility when interviewing, that participants will not provide accurate accounts and that they may present an identity to the interviewer or deliver what they think the interviewer wants to hear (Dingwall, 1997). This type of scenario occurred during the initial interview with Arun:

During the interview the teacher seemed tense, checking the answers were what I wanted and again I stressed that there was no right or wrong, just what he thought and did. I felt that he was thinking he needed to conform to something I want and I decided to try and explain that the study was not judgemental or set up to try and prove something – it is set up to try and explore teachers’ thinking and gain perspectives on their practice.

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The important thing here seemed for me to provide my own account – to reiterate the purpose of the interview method in this project, namely to explore what the teachers think about their practice; that I was not hoping to prove anything or test anything and I didn’t require any set piece responses. It occurred to me that building foundations
into the researcher-participant partnership was hugely important and considering the situation from a relational ethical dimension (Stutchbury and Fox, 2009) constructing a common understanding was something that shouldn’t be presumed simply because I had handed out an information sheet.

3.4.7.2.4. Lessons from pilot interviews
The interview processes were subject to piloting. However, during the small pilot study I did not use an initial interview, just conducting a final interview to capture a picture of the teacher’s ideas about using group talk. I realised after this small study that it would be useful to have constructed some sort of initial picture of teacher’s thinking so the decision was made to incorporate this into the main study. The card sort interview was piloted separately with two other teachers who I knew well. I found this useful as a practice run at a new and unfamiliar technique but it also clarified my thinking about the purpose of the activity and that I should view this method as a catalyst for a conversation between researcher and participant, rather than for the production of rep-grids for quantitative analysis (Fransella, Bell and Bannister, 2004). This piloting opportunity also allowed me to check my newly created initial interview questions. What emerged from this wasn’t any particular change in the wording of questions but an appreciation of the experience of the participant. Despite being long standing colleagues and the interview being conducted in a relaxed environment, they both said they had feelings of nervous anticipation; that although they knew me well and they were helping me, they were worried about what would be asked and how it would feel. From a relational ethical perspective (Stutchbury and Fox, 2009) this revelation was important because it gave me an appreciation of the participant viewpoint at a time when as a novice researcher I was understandably wrapped up in my own role.

3.4.7.3. Interviews with pupils
The ontological backdrop for this study makes the assumption that within the social context there will be multiple perspectives on any event. This being the case, it was important to incorporate the accounts of the pupils as well as the teachers. This is also
in line with the move in social research towards viewing children as social actors, with their own story to tell and seeing research as being with children rather than on them (Darbyshire, Schiller and MacDougall, 2005, Fargas-Malet et al, 2010, Mayall, 2000). Hearing the children’s perspective expands the complexity of the research process (Christensen and Prout, 2002) but provides a more authentic account of the social context. The interview method was therefore drawn upon once again.

3.4.7.3.1. Unknown challenges

During the pilot study, I conducted some interviews with pupils, asking questions related to their experiences of group talk and how they felt it was useful. The interviews went very well, having a relaxed feel about them but I had known the children for some years, had taught most of them myself and therefore already had a well-developed relationship through which to conduct the interview. The questions I asked were not specific to the lesson and captured more general views. Although this strategy provided interesting accounts, I realised that for the main study I needed something more specific; insights from the pupils which related to the learning in the lesson where I had recorded their talk. Therefore, I decided that moving forwards I would interview each one of the children in the focus group after the observed lesson where they had been using peer discussion. Having spent many years working as a teacher, where asking questions of children was my bread and butter, I felt well prepared for this process and went about setting up interview questions which I hoped would encourage children to talk about the lesson and how using group talk had helped them with their learning. However, I was naive about the challenges ahead and the initial impact of one such challenge had an effect on the way I continued with this method during the rest of the study. Some researchers feel less confident about working with children, giving more attention to interview processes with them and take for granted the way in which they obtain views from adults (Hill, 2006). I was guilty of the opposite, of not considering how tricky it could be with children.

I conducted my first two sets of pupil interview with individuals and began by explaining once again the purpose of the interview to each child. Following the advice of Cameron (2005) who suggests that gaining assent before interviewing children is of
value because it may be reassuring, I allowed time for each child to handle the audio recorder and ask questions about it before asking them to press the record button when they were happy for me to ask my questions; questions about their learning, which parts of the lesson had helped them and how talking had helped them. The interviews appeared to go well enough but I found I captured only brief accounts from most of the children and I put this down to unfamiliarity with the situation as well as with me. During the third set of pupil interviews, the first with Simon’s class, I had a very uncomfortable experience when one of the children became visibly upset during the interview as I was asking him about his learning during the preceding lesson. I immediately turned off the recorder and switched the focus of discussion to the class story book and the volcano he was making as part of his topic work. The situation was recovered but I realised I needed to think more deeply about how I was working with this method.

3.4.7.3.2. Rethinking the method

Listening back to the recording later that day I began to consider my own role within the pupil interviews. It occurred to me that perhaps I was asking questions like a teacher, checking up on what was learned; it was certainly possible that this was how the children may have viewed me (Hill, 2006) and perhaps then saw the interview as an extension of the classroom. I was Mrs Hewitt, watching lessons and now asking questions about who had learned what and how and they didn’t even really know me. On reflection, it was an intense situation which certainly held ethical issues to be teased through, not only those connected to the consideration of power dynamics between interviewer and informant and how the asymmetrical positioning can be intimidating for the pupil but also those surrounding my perception of the pupils’ role in the study. The way a researcher views a child affects the approach taken and the way they listen (Punch, 2002) and the role researchers take themselves is important (Christensen, 2010). I realised that I needed to question myself - was I seeing children as learners to be assessed or as informants and partners in the study. It was an uncomfortable reflection and one which led me to think about the kinds of questions I was asking and how I had set up the process of collecting children’s accounts. I also
needed to remember that my role in the process was not as teacher with an entrenched tradition of working with and seeing children (Darbyshire, Macdougall and Schiller, 2005b) but as a researcher who just wants to find out what children think about things (Mauthner, 1997):

*I need to ask questions and be responsive but not behave like a teacher, be more relaxed. I have a different identity now, different reasons for asking the questions. I need to remember that.*

It seems that the stance that I had taken was led more by the view I had of myself as teacher and through the design of the interview, I was positioning children as learners to be studied rather than partners to be working with in the research process. By reflecting upon this ethically important moment (Gildersleeve, 2010, Guilleman and Gillam, 2004) I had confronted a discrepancy between the epistemological foundations for the study and the way in which the activity was developing in practice. The discomfort of the reflection was crucial in enabling me to draw myself away from a reliance on customary perception and move to consider children as informants.

It also occurred to me that perhaps I had become so accustomed to working with children in a particular way and taking a particular stance that I had not made myself aware of the more hidden aspects of working with children in the research process. For example, there was perhaps an issue about consent. Of course, I had ‘informed consent’ to interview all the children taking part in the study but perhaps this ethical concept is somewhat fuzzy when considered in more depth. Once the school and teacher had agreed to take part in the study, the next phase had been to inform children and parents. I was introduced to each class when I spent a familiarisation day amongst them, the study was explained by the class teacher and the children were given the chance to ask me questions if they so wished. Letters and information sheets were then sent home according to the process I had detailed in my application for ethical approval (Appendix 1.1 p.293). Children who formed the focus groups were made up of those who had completed the informed consent forms but it is worth considering how much the children themselves consented to the process and how much this was done for them by teachers who had decided to take part in the study with their class and by parents who have been the ones to sign the form. Although I
had incorporated an assenting process at the start of the interview, it is perhaps difficult for children to refuse when adults have given consent and children may feel placed in the interview situation, in a kind of involuntary role (Hill, 2005, Cameron, 2005).

Following this experience and taking the advice ‘awareness of the effects of research on children must alert us to when we may need to refrain from using a certain methodology’ (Christensen and Prout, 2002, p.489) I reshaped the pupil interviews. I constructed them as pupil groups, which have been defined as ‘a group conversational encounter with a research purpose’ (Lewis, 1992, p.413). I hoped that this would perhaps create a safer, more supportive peer environment (Mauthner, 1997) allowing children to feel more confident, at ease to talk (Mayall, 2000) and that it would go some way to redressing the power imbalance (Clark, 2005, Hennessey and Heary, 2005). A group interview also provides more opportunity for thinking time and the dynamics of a group context may present more opportunities for questioning of the interviewer (Lewis, 1992), both important features which may allow children to feel a sense of control. I also needed to be aware of viewing my role in the interview as encouraging children to share their experience; of facilitating not leading and trying to set myself apart from the authority figure of teacher (Hennessey and Heary, 2005). With this aim I chose a more relaxed area for the group interview, away from the classroom (Mauthner, 1997) although there was a time when the corridor area had to suffice due to space restrictions on that day. The children chose the area of the room to be seated, sometimes we sat on the floor, sometimes around a table and I found that they enjoyed listening to small slices of the recording of their group discussion that I had just taken in the classroom. It was both a wonderful icebreaker and a useful way into talking about the lesson.

Taking time to think deeply about the pupil interviews, I became more aware that the structuring and ordering of the questions was important (Hennessey and Heary, 2005) as was the wording:

Thinking about trying to word the questions so children feel happy to talk is important. The children have to feel that there is no right or wrong. I have up to now selected ones that asked children to respond in particular ways but
perhaps this has made them feel like there was a specific answer. Giving more
general and comfortable questions which will allow children to talk more
personally about what they know and feel will perhaps elicit more discussion
and give me the ability to further explore with questions added in dynamically
where pertinent. The important thing is to make sure they feel relaxed.

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The first question of the interview invited children to just share their experiences of
the preceding lesson, what they liked or didn’t. The aim of this was to encourage them
to share experience through a description of events and in addition, asking about
things they already knew and for their opinion, might allow the children to be more at
ease when giving responses (Cameron, 2005). This was followed by questions designed
to explore their ideas about what they had learned and the ways in which talk had
enabled this (Appendix 3.4 p.305). After the interviews, the pupils’ responses were
transcribed and a copy sent to the teacher before the next observed lesson. The pupils
were aware that this handover was going to happen which perhaps could be seen as a
threat to validity due to the possibility that they may then not feel able to give full and
authentic responses. However, as will be drawn out at a later point the pupils did in
fact feel that the interview was a space where they could provide honest feedback on
their learning experiences.

3.4.7.3.3. Pupil interview data issues
Although the process had been restructured to take account of the pupils’ levels of
ease with the interview and this seemed to have had an effect on the overall
atmosphere in the interviews, I was still only able to collect rather short responses
from children. Perhaps this was due to my apprehension after a challenging initial
experience, that it was me that wasn’t comfortable and I wasn’t prompting in open
enough ways or perhaps the skill of interviewing groups of children for the purposes of
research takes more time to develop; managing focus group interviewing with children
has been found to be difficult to manage (Smith, Duncan and Marshall, 2005). The
importance of building good fieldwork relationships was also emerging through the
reflection on the pupil interviews:

*Listening to the children’s interview again it makes me realise how difficult it is
to encourage the children to open up. From their perspective I am an unknown*
person just in the classroom every once in a while – why should they open up? When I did the pilot study the children were so much more free to share their ideas – but I already had a strong relationship with them and knew them well. These particular children I have been with today are really mature, talking and discussing well in their groups. So I realise that their relationship with me is not yet at the stage of openness. Maybe I need to spend more time in the classroom but this is difficult as I only have a set amount.

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I felt that by adapting my method in the ways described, I was more attuned to the children’s experience of the research process. When I set the group up for the first time in Emma’s class, one of the children said ‘ooh this is better. I didn’t like it last time’ and in Simon’s class one of the children said ‘It’s not too bad really this’. To this end, having a group interview was a positive change, however I found that there were a number of occasions where children simply agreed with other group members and this meant that I captured responses that were not elaborated. For example when asked the question ‘How did talking to others help your learning?’ after a lesson on the topic of shadow formation I captured these responses:

Oliver: It finds out other people’s ideas
Nigel: Finding out new things like er I’ve forgot now
Beth: Like it helped me to find out what we were doing
Lucy: It helped me find out new things

ARUN PUPIL FG INTERVIEW 2

And this extract from an interview with Emma’s group when they were discussing what they had learned:

Sam: I learned that if you leave it in a normal classroom cold water will go up tap water will go up and warm water will go down and more stuff about fair testing
Ellie: Same as me
Nathan: And me

EMMA PUPIL FG INTERVIEW 4

In these extracts, with each new contribution, I was not able to understand anything new or gain further insight, perhaps because each additional confirmation of the same idea limited a more in depth expression of ideas. This type of interaction obviously has
an impact on the quality of the data collected. There were also times during the interviews when the children began to go off topic or talk at length about the lesson in ways which were not necessarily pertinent to my inquiry or even argue with each other. My role then became to steer the discussion back on course and I was especially aware of doing this efficiently because I had been allocated a limited time with the children and they were missing their lessons back in the classroom. This created a tension in my role – on the one hand I needed to create a comfortable atmosphere where children were encouraged to share ideas and take a lead with content (Hennessey and Heary, 2005) yet I knew I had time constraints and a research agenda to fulfil.

Although it is an epistemological assumption that the data produced during an interview is a co-construction, the focus for analysis of the interview transcripts is the content, not the interactions occurring within interviews. However, it is interesting to note how at times during the interviews, children built upon each other’s ideas to produce more elaborated accounts, as in the following example from an interview with Simon’s focus group when they were talking about the parts of the lesson they had learned most in:

_Ella: When Mr Y was teaching us on the carpet_

_Tom: Yea at the start when we were getting shown what we were doing on the carpet because he was er showing us stuff_

_Ella: He told us what to do ‘cos if he didn’t tell I wouldn’t have chosen_

_Mark: I can’t think_

_Andrew: I can’t remember_

_Tom: Mr Y_

_Ella: He helped us come up with a question_

_Tom: We all helped each other_

_Andrew: Yea we all did something_

_Ella: I think Tom was quite helpful he kind of like directed us and if I had been with my friends I wouldn’t have been directed I would have been silly_

_Tom: It helps you learn more when you’re not messing about so much_
Mark: Mr Y and everyone else because they all did something because if we didn’t have Tom we couldn’t have done the torch bits

Andrew: Mr Y

SIMON PUPIL FG INTERVIEW 3

Although the contributions from the pupils are brief, as has been mentioned previously was the case throughout most of these interviews, it is possible to see how one response has an effect on another. Initially Mark was finding it difficult to contribute but was later able to build on what Tom and Ella were saying. It is also possible to see how Tom’s change of direction to think about pupils helping each other, allowed the group to move onto a new topic and share their idea. This short example shows a positive impact of using a group interview method on the data collected, as informants are apparently stimulated to think more deeply or in new directions (Hobson and Townsend, 2010).

In conclusion, the use of group interviews with the children after each observed lesson was an important part of the methodology and provided some interesting and useful insights which contribute to the inquiry in a positive way. However, the data collected was not as rich as I had hoped for, for the reasons explored above and perhaps a wider range of methods to allow these participants to express their views could have been employed (Davis, 1998). It could also be that the children did not possess the metacognitive awareness of their learning through talk to contribute in any depth, that ideas I was searching for were not well developed or beyond their reach or perhaps I fell into the trap of focussing on creating a positive experience for children rather than on the effectiveness of the method (Hill, 2006). Other lessons learned relate to the central place of critical reflection on my role and assumptions throughout the research process (Davis, 1998); of working reflexively with the application of methods within the fieldwork (Punch, 2002). My initial approach to the pupil interview had been incongruent with the philosophical backdrop I had laid out; there was perhaps an uneasy coexistence of perspectives – what I had acknowledged theoretically and the one I was working with in practice. This meant that I needed to reconsider not only my own role but the way in which I perceived the role of children in the research process. In addition, I have begun to understand the complexity of
ethical considerations and the importance of seeing these as something to be alert to and monitor in an ongoing way, not just as formalities to be attended to at the outset of the study, in particular of taking an ‘ethical symmetry’ approach (Christensen and Prout, 2002, p.493) where the rights, feelings and interests of children should be given as much consideration as those of adults.

3.4.7.4. Oral diaries

3.4.7.4.1. Why use a diary?
The use of a diary was chosen as one of the research methods firstly because it is considered to be a useful tool for encouraging ongoing regular reflection (Bolton, 2001, Moon, 2006). Its purpose in this study was to prompt the teachers to observe themselves immediately after a lesson; to cast their mind’s eye over recent experience, relate their thoughts and interpretations, recount illustrative excerpts and to describe, analyse and reflect upon significant moments in relation to how pupils had used group discussion for their science learning. It was hoped that regular and focussed reflection upon the use of peer group talk in science would give rise to the teacher working with and trying out a range of ideas in the classroom, allowing for interesting and varied naturally occurring data through the duration of the project. In addition, by documenting the reflective diary accounts across a whole school year, it was hoped that a dynamic and subjective picture could be constructed and that any changes in teacher thinking about the use of group talk in science could be discerned (Plummer, 1983).

Diaries can be used under differing methodological umbrellas, for both quantitative and qualitative research (Corti, 1993, Duke, 2012) and across a range of disciplines (Chetcuti, Buhagiar and Cardona, 2011, Katz and Misler, 2003, Monrouxe, 2009, Nunan and Bailey, 2009). In qualitative social research they are used to explore the complexities of human behaviour and practice and collect information about a particular topic (Bryman, 2012). These solicited diaries created with the research clearly in mind, completed by participants with a focus on the issues central to the study and with the knowledge that they will be read and interpreted by the
researcher, are a specific methodological tool, the aim of which is to gain a ‘view from within’ (Zimmerman and Weider, 1977, p.484), to encourage participants to focus on activity that they value or perhaps carry out subconsciously and therefore take for granted. They are flexible tools, can be used to encourage a retrospective account of experience or reconstruction of practice and collect data over extended periods of time (Bolger, Davis and Rafaeli, 2003). They can yield information about the life of the author, making experiences visible which are often hidden (Elliott, 1997) and provide researchers with possible insights into participants’ worlds; a way to begin to understand how events are perceived and understood (Block, 1996, Bruner, 1993, Kenten, 2010). In these ways, the diary had a dual purpose in this study; to provide a space for teacher reflection but also capture it for exploration.

The asymmetry in the researcher-participant relationship is relevant to consider when using diaries which are co-constructed by the author and researcher (Elliott, 1997, Kenten, 2010). The researcher could be viewed in a position of power due to the choice of design and analysis of diary data and this may have a restricting effect on emerging description and commentary. However, Meth (2003) suggests that diaries can also be seen as a tool of empowerment for participants - a space for them to develop insight and understanding of their own experience, give voice to ideas and reflect on their own professional action (Day and Thatcher, 2009).

Diaries are most effective when used in combination with other research tools, rather than in isolation (Crosbie, 2006, Duke, 2012, Kenten, 2010). For example, Taylor (2013) used audio recorded diaries with children to capture developing thinking on the notion of place after geography lessons. She noted that the diaries provided key insights which complemented more naturally occurring data collection opportunities. I decided that this idea of integrating the use of diaries alongside other methods in my study would be beneficial and could provide a strategy for gaining a range of perspectives, leading to deeper understandings of the issue under study and a step on the road to greater knowledge (Flick, 2009).
3.4.7.4.2. Diary format

The issue of time had an impact upon the planning of the diary entry in a two ways. The first centred on the timing of the diary entry directly after a lesson, which I knew was important; collection of a contemporaneous account, close in time to the experience possibly results in less self-censorship or reframing, reduces retrospection bias, minimises recall issues and ensures small details aren’t lost (Bryman, 2012, Elliott, 1997, Kenten, 2010). However, a primary school teacher is a busy person, with one lesson following on quickly from another, often with little break in between to collect thoughts together, never mind to stop and make time for a reflective diary entry.

Much of the literature on reflective practice discusses the use of written diaries or learning journals (Bolton, 2001, Moon, 2006) and it has been noted that they allow for more intimate introspection than interactive, face to face accounts (Day and Thatcher, 2009, Jacelon and Imperio, 2005). However they also bring with them significant issues around participant burden (Iida et al, 2012) which can impact upon collecting enough detail for research purposes (Corti, 1993) or even deter some from participating (Spowart and Nairn, 2014). Despite the advantages of using written diaries as a research tool they clearly present challenges for the participant who must have the willingness and time to maintain one as a systematic record of events (Bryman, 2012). I realised that the use of written diaries in my study may imply a lack of empathy with participants’ busy schedules and therefore, in order to have as little impact on their time as possible I decided to draw on the idea of audio recording entries which had emerged from the literature (Block, 1996, Taylor, 2013). In this way the reflective diary for the study became a reflective oral diary recorded on an audio device, with the teacher talking through their thinking immediately after the lesson. This plan seemed to go some way towards avoiding imposition, mitigating the relational ethical issue (Stutchbury and Fox, 2009) of expecting participants to spend huge amounts of time making written records. As another measure, a ten minute time frame was put on the reflective oral diary entry, so that it did not impact too heavily on the myriad of post lesson teacher tasks.
3.4.7.4.3. Diary prompts

It has been noted that giving participants guidelines around which to focus their diary entries is beneficial because it can lessen participant selectivity (Alaszewski, 2006, Plummer, 1983) and also that such prompts can orientate yet not determine the record (Block, 1996) and I decided that this would be a useful approach to adopt. I created open prompts (Appendix 3.5 p.306) based upon a reflective cycle (Kolb, 1984, Scaife, 2010) covering issues relevant to the research. This also follows a common protocol for diary design where participants answer a series of questions at a fixed time (Iida et al, 2012). In this way, each reflective oral diary entry engaged the teacher in an open dialogue based around this set of prompts regarding their thinking about the observed lesson. The initial prompt invited the teacher to recall and describe significant or critical events from the lesson and what their feelings were, in particular about the collaborative talk. In this way the narrative diary nature of the dialogue was reaffirmed but also it provided a familiar way to begin the new entry. Other prompts triggered teachers to reflect upon things such as planning decisions, conclusions about learning, the impact of the collaborative group talk approach and thoughts about pupil experience.

3.4.7.4.4. Diary entry in practice

The teacher and I engaged together with the diary account in the immediate minutes after the lesson, as soon as was practical for the teacher. Usually this meant waiting until the children had gone out to play or had gone home for the day and throughout the year’s study I was generally able to facilitate each oral diary entry within ten minutes of a lesson being finished. It was a very simple set up; all that was required was the list of prompts for reference and then the recording device laid upon the table between us, switched on when the teacher said that they were ready and comfortable to begin and switched off if anyone else entered the room. The recording usually occurred in the classroom but on some occasions the teacher asked to move to another more peaceful room, when flute lessons or ‘golden time’ (an often noisy free choice pupil reward session) were nearby! I led the teacher through the prompts and listened as they recorded their thoughts. Each time a diary entry was recorded and I
took it away to create a written narrative summary (Clayton and Thorne, 2000) and this was sent to the class teacher by email as soon as was practical. The sharing of the written summary served two functions: the teacher reflections reported within it could be confirmed as a correct representation for internal validation purposes and if the teacher so wished, the documents could be collected together to create the story of their practice and used alongside a more formal written reflective diary which had also been provided (Appendix 3.6 p.307). This was designed as a place to record any further reflections after the audio recorded entry, however not one of the teachers made use of this. There was also an open and repeated invitation to give reaction to the written summaries of the diaries; this only occurred once in the duration of the project.

From a practical standpoint, the fact that I myself had facilitated the recording of the diary entries immediately after the lesson meant that there were almost no issues from participants being unable to or not having the time to do these themselves, which would have given me an incomplete data set or truncated entries. In addition, being there allowed me to begin to interpret by noticing how participants assigned significance to events highlighted during the diary entry (Alaszewski, 2006, Duke, 2012). However, the fact that I was present during the reporting and recording process, could have meant that the teachers felt less inclined to speak honestly and openly, especially at the outset of the study, before teacher-researcher rapport had been established (Berzano and Riis, 2012). I was aware of this possibility at the close of the pilot study when the participant indicated that she may have felt uncomfortable in making the oral diary entry with an unfamiliar person and this highlighted early for me the need to create good relationships with participating teachers at the outset of the study.

3.4.7.4.5. Benefits and challenges of the oral diary

During the course of this project the oral diary method provided rich examples of reflective teacher thinking and there were many occasions when teachers openly questioned themselves and their practice whilst making their entries. Sometimes a real mix of emotions about practice was fresh for capture in the timely oral diary entry.
but the sustained diary keeping also meant that the teacher’s ever changing present (Plummer, 1983) was recorded. Interestingly, there were also times, when analysed alongside other methods of data collection, the oral diaries revealed reflections which were at odds with those elicited from pupils. Examples of such reflections are drawn upon in the following analysis chapters.

One limitation in the use of oral diaries may be that at certain times of day the teacher’s thinking at the end of one lesson may have moved straight to the next. In fact I did assist one of the teachers to set up the classroom for the following session on a number of occasions in order to allow him time to make an oral diary entry while the pupils were on their mid-morning break. On another occasion a different teacher asked if they could email me written reflections due to her hectic schedule. I hesitated slightly to respond to this request because I was aware that writing the entry would perhaps allow for neatly shaped and crafted metacognitive thoughts which are clearly interesting and important for practice but through the oral diaries I was aiming to capture the more immediate, affective or messy kind of thinking (Zembylas, 2005). The teacher must have noted my awkward reluctance and very quickly she said she would in fact manage the time after school. On reflection, the placing of the diary entry with me as soon as possible after the lesson, whilst based upon an empathetic understanding of teachers’ busy lives and ethical considerations around taking up participants’ time, as previously mentioned, maybe in some ways placed unintended pressure on them. In addition, perhaps in these tightly timed situations, although the immediacy of the oral diary entry was useful for capturing initial and fresh thinking, there may have been a trade off in the level of depth that was possible. These concerns are illustrated in an extract from my research journal:

_I hope that short reflections are going to give me enough information. I need to choose my prompts carefully._

As this shows, I became conscious of the need to have some flexibility in the use of the set prompts if I was to draw as much as possible out of the relatively short time for the reflective oral diary entry and not allow them to become a mechanistic operation. To this end, I realised the importance of reacting to comments that emerged; not just moving on to the next possible prompt in the list but listening carefully and responding
where necessary so that diary entries varied slightly based on responses and follow ups:

This sounds obvious but in fact in the practicality of the moment, with the clockwatching and the knowledge that there is a recorder there so everything is being taken down for me, it could be easy to be too relaxed and miss opportunities to really listen to what the responses are and explore further.

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The on-going nature of the oral diary data collection and the use of researcher guidance for reflective entries made it possible to stretch the response time and tailor prompts. For example, after one of Emma’s lessons differing perspectives on the learning experience were offered by the teacher and pupil participants (this lesson will be explored in more depth in Chapters 5 and 6) and so in the diary after the next lesson, it was interesting to prompt Emma to think about the experience of the pupils, something which she had not touched upon during the earlier oral diary. The oral diary design was significant here also because it allowed for flexibility. Being able to explore a theme which emerged as the study progressed was a useful characteristic in terms of allowing for the collection of relevant data in a personalised but collaborative way, clarifying or expanding issues as necessary (Zimmerman and Weider, 1977). Of course it was important to remain with a core bank of prompts but the potential to have space to responsively explore emerging analytical themes proved fruitful in revealing teachers’ possible priorities when thinking about teaching and learning through group discussion in science. In this way understanding was perhaps co-constructed, the diary not being the product solely of the teacher (Elliott, 1997, Kenten, 2010)

This probing approach was discussed earlier in the consideration of the interview method. The oral diary however, differed from an interview in that its purpose was more than data collection for research; it also constructed a space for professional reflective thinking and knowledge construction for teachers (Hewitt, 2015) (Appendix 11 p.396). In addition, the method created a log of experiences related to the same subject over time, a characteristic of the diary. Although the strict timing I had allocated to the diary entry was a limitation, its contemporaneous nature meant that fresh and affective thinking was captured. In addition, initial analysis provided a
platform for the exploration of themes and as will be explored in the next section, the method afforded a space to develop and maintain fieldwork relations.

3.4.7.4.6. Importance of fieldwork relationships and developing rapport

I have previously touched on the importance of developing positive relationships with the pupil participants and this was also important with the teachers. Initially they were slightly reticent about the project, expressing interest but also reservation about the impact upon their time. I realised that I would have to make every effort to establish trust, knowing that collaborative relationships are seen to be the essence of effective interpretive fieldwork (De Laine, 2000) and building rapport is key to the uncovering of honest and open data through methods such as interviews or diaries (Pitts and Miller-Day, 2007, p.191). In addition, (Berzano and Riis, 2012) advise that the use of diaries as a research method must allow time for the development of sufficient intimacy to enable narratives to emerge. In order to establish positive perceptions and generate reassurance from the outset, I began the fieldwork with very clear explanations of the aims and nature of the study (Wall and Stasz, 2010). I found that the oral diaries also provided a space to build relationships and rapport and reach a ‘linking stage’ with participants (Pitts and Miller-Day, 2007, p.191). Table 3-4 provides a brief overview of this and Hewitt (2015) presents a more detailed exploration (Appendix 11 p.396).

The regular routine of the oral diary entries not only gave access to reflective professional thinking but perhaps in some way it also informed and shaped the relationship between the participant and researcher, building a bridge over the gap in roles, as progressively it became a more and more comfortable and familiar constant. This research journal extract shows how as the study developed teachers became more relaxed and at ease:

\textit{After the lesson the teacher mentioned that now she felt very comfortable with me coming in – that at the beginning she wanted to prove what she could do and now it is just ‘oh Liz is coming in’}. \textit{Researcher Journal Feb 28\textsuperscript{th} 2013}

The development of positive fieldwork relationships through the study possibly also had an impact upon the final interviews which were more extended than the initial
ones, in terms of the participants’ responses and my level of confidence in probing to explore ideas more deeply.

Table 3-4: Overview of how oral diary entry helped to build relationships

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<tr>
<th>Oral Diary Entry Practice</th>
<th>Impact</th>
<th>Tension</th>
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<tr>
<td>Before first entries - sharing professional histories; establish common ground.</td>
<td>Enabled intersection of perspectives and construction of similarity (Abell et al, 2006, Berbary, 2013). Establish relationship, open up communication and create ease for initial oral diary entries.</td>
<td>Need to be mindful of ever present researcher subjectivity and ‘exercise wisdom’ - self-disclosure can lead to muddying the data with personal accounts (Roulston, 2010a, p.16).</td>
</tr>
<tr>
<td>Pre-diary entry informal/professional chat; relating of anecdotes from the lesson.</td>
<td>Air of joint participation emerged. Allowed for discreet reassurances for the teacher that this was a collaborative meaning making exercise (Mahoney, 2007). Regular space to continually construct rapport - no ‘time-out’ in field relations (Silverman, 2005, p.256).</td>
<td>Balancing proximity and distance (Silverman, 2005, p.266). Participating, sharing stories, building connections important but need to be ‘professional stranger’ - accepted and familiar yet remaining distant</td>
</tr>
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</table>
3.4.7.5. Supplementary data collection

In addition to the main methods of data collection detailed in the previous sections, I also collected teachers’ lesson plans when they were available, however only Arun gave me these documents each time and I was only able to secure one from Emma. In addition, I found my own research journal a really useful space to note down how I was experiencing the research process, a type of natural history for the fieldwork (Silverman, 2005), a place to explore impressions of my own role, notes on how the project was progressing, difficulties that presented themselves and how participants were reacting to the study.

3.5. Methodological issues and ethical considerations

Ethical research is that which does no harm, that which creates trust, respect, fair treatment and open dialogue (Simons, 2009). The research was designed with ethical issues in mind and following ethical guidelines (British Educational Research Association, 2011). At the outset, I was most careful to express my wish not to take too much teacher time and how the study had been designed to minimise this and also that I wanted to collect the perspectives of both teachers and children. I collected informed consent forms from Heads, teachers, parents and children (Appendix 1.2, 1.4 and 1.5 p.294-297). I supplied teacher participants with information about the project, using a leaflet and a letter explaining the reflective process involved (Appendix 1.3 and 1.4 p. 295-296) and also incorporated an ongoing assent process by using a participant validation for the oral diary entries.

However, ethical research is not simply about the technicalities and it is important to move beyond a procedural understanding (Clayton, 2013) and develop the capacity for deeper reflexive consideration in the navigation of ethical issues which can arise in the day to day experience of conducting research (Burgess, 1989a, Guilleman and Gillam, 2004). I have woven through the earlier method sections, my reflections upon a range of ethical issues that I encountered and explored how I attempted to resolve them; issues around access and consent, power and relationships and the way participants are viewed. The following section aims to highlight further ethical considerations related to issues surrounding the stance of the researcher at different points in the
research process and how this impacts both upon dynamics in the field and the process of data collection.

3.5.1. Role of the researcher

A researcher performs a role or takes up a particular stance in the field of study. Gold (1958) suggests that this position may be categorised in terms of a continuum; from being the ‘observer’, who stands back and limits interaction to ‘participant’ who fully immerses themselves in the life of the informants, perhaps even ‘going native’. Other classifications also relate to the level involvement in a research setting such as Adler and Alder’s (1987, in De Laine, 2000) notion of peripheral, active and complete membership. Being an outsider means that a researcher can be a stranger, stand back and approach the new situation in a questioning way, abstracting material with new eyes (Burgess, 1984) however, they may also misinterpret localised meanings (Schuetz, 1944, Thomson and Gunter, 2011). Being an insider means that a researcher has knowledge of the culture and structures of the context, a shared frame of reference which brings greater insight. However there is also the possibility that due to assumptions based upon familiarity, a researcher may not ‘see’ things and therefore full coverage of situations may not occur and in addition the study may suffer from a lack of the criticality of distance (Delamont, 2002). Ideas about being an insider or outsider in relation to the context of research and participants seem neat and tidy at the outset of doing research but it soon becomes evident that in reality settings can be both familiar and strange (Burgess, 1984), positions shift and therefore a researcher’s role is liquid (Thomson and Gunter, 2011), ‘processual and ever-changing’ (De Laine, 2000, p.95). The insider/outsider binary is perhaps rather simplistic then and I have explored the fluidity of roles in the research process in one of the settings in Appendix 5 p.310. Indeed there were times when I was simultaneously in both roles for different settings (McGinity, 2012). For example at the outset of doing the research project I was an outsider, new to the academic research arena. I was the stranger (Schuetz, 1944) approaching a new culture and experiencing the disorientation that goes with this. Yet I was also insider because I was planning research based upon my own
professional experience and had practical knowledge of the research issue: importantly, I was beginning in ‘familiar territory’ (Silverman, 2005, p. 39).

An exploration of how the position of the researcher may impact upon processes in the context of this research project is given in Appendix 6 p. 313. Through this analysis, I acknowledge that the position I take up in the field has a basis in what I bring to the study in terms of my own background and knowledge and understanding. My positioning was jointly negotiated and fluid as over time I roamed the researcher continuum ‘in a context of shifting power relations’ (De Laine, 2000, p. 118). The way in which I was positioned was connected to methodological assumptions about the research, the research setting and the relationships held within it and also my own personal and professional background. Balancing such varying positions and roles, while still keeping the research questions in the forefront of my mind was a challenging and sometimes unsettling process but one through which I learned the importance of both flexibility and of bringing the issue to consciousness in order to understand its impact upon the process of knowledge construction (Burgess, 1989b, Hellawell, 2006, Merriam et al, 2001).

3.6. Conclusion

The project design presented in this section was developed to address specific research questions which I was interested in answering. The decisions I made at the outset and along the way shaped the project and enabled me to collect data to explore the topic. Some of the methods used to construct the research design elicited more rich and full data than others and the sources come together to collect a range of perspectives but how much I was able to build an authentic understanding is uncertain:

Perhaps I didn’t really get to the heart of the teaching though – just scraped the surface. All the teachers have disclosed at some point or another that they teach like this especially when I am in (table arrangements change when I’ve gone, having to think of something to do for when I’m coming in, I’ve become more natural but wouldn’t do it like this for Ofsted!). So am I really getting the picture or just the start of an idea of the ways in which teachers think about and put in place group discussion in science?

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Alongside the development and use of the methodology, I developed an understanding of the complexity of knowledge production and the interrelated nature of methodological and ethical issues.

Moving on from this discussion of the methodology of the study, in the next chapter I will demonstrate how the analysis of data was conducted.
4. Process of Analysis
4.1. **Thematic analysis**

The overall approach to analysis was an inductive one; induction is a distinctive feature of qualitative inquiry and involves starting with the data and allowing theory to emerge from the ‘bottom-up’, rather than having a hypothesis to be tested. The reasoning behind using an inductive approach is that it allows the researcher to appreciate the perspectives of the participants and not be limited by their own history and interest. It also leaves open the door for assumptions within the research question to be challenged (Hammersley, 2008). In order to purposefully probe the data and begin to unpick the complexity of the situation, a thematic analysis approach was taken. Thematic analysis is a foundational method for qualitative analysis, providing a ‘flexible and useful research tool, which can potentially provide a rich and detailed, yet complex account of data’ (Braun and Clarke, 2006, p.78). It involves a process of organising and working with the data through the exploration of themes (Gibson, 2010). The interview, oral diary and observational data were analysed using this framework.

In this chapter I will explain the analytical processes I went through with the project data, from the macro analysis at the initial stage, the purpose of which was to get the feel for the data as a whole, to the later micro analysis, in order to gain more in-depth insights. Making this process explicit will show how the stories and themes emerged from data and provide a platform upon which the later presentation of data can rest. An overall diagrammatic representation of the thematic analysis process is given in Figure 4-1.

4.1.1. **During early data collection – dynamic analysis**

Ideally, qualitative analysis should begin during data collection; ‘go to it!’ suggests Silverman (2005, p.152), even if you only have one data extract. The analysis should be an ongoing practice providing insights which may lead to research questions being iteratively developed or data collection tools such as interview questions being added or altered (Gibson, 2010). Analysing data in this more fluid style can provide opportunities to explore emerging themes in depth and this process is therefore theoretically desirable. However in practice I found a constant structured analysis of
Figure 4-1: Diagrammatic representation of inductive analytical process

- Transcription of peer group talk; transcriptions returned to participants and their analysis collected through diary.
- Transcription of interviews and oral diaries provided opportunities for initial unstructured analysis.
- Notes in the research journal – raw analytical comments.
- Possible themes identified through structured analysis at points during ongoing data collection – changes in teacher thinking; tensions in teacher thinking about talk.

- Read all data; broke data content down; produced summary charts.
- Used final interview data summary to initially identify possible themes for further analysis; consolidated ‘Tension’ theme through prevalence of responses indicating challenge and through group talk data which shows an erratic pattern.

- Coding process - beginning with teacher interview/diary data and using Nvivo as a tool; layers of coding led to development of a master coding system; coding also revealed apparent changes in teacher thinking.
- Creation of master teacher thinking map from product of coding processes; themes for more in depth analysis were identified for subsequent exploration.
- Coding process using pupil data; Nvivo used as a tool; creation of a map of pupil thinking categories.

- Use of final interview question on changes to identify themes of change.
- Chronological account of teacher thinking written for each teacher participant, using interview, oral diary and observation data.
- Deductive analysis of chronological accounts; coded to identified change themes; other data sets explored for supporting or challenging data related to change themes.
incoming data tricky to manage due to other work commitments during the data collection phase. In addition, having the confidence to alter data collection instruments on the basis of ongoing analysis was a challenge, although there were times through the project where I tried to work dynamically with the data to ensure I was picking up on emerging ideas:

I prompted during the diary entry today, aiming to get at the way group talk was organised and structured. This seemed to be helpful as it occurred to me that I was not getting specifically at this part of the planning process and that this was something of interest.  

I have noticed that Simon does a lot of moving between groups across a lesson. The aim is to study the natural happenings of the classroom, to study the teacher’s way. Maybe I could use this as a discussion prompt in the next oral diary – about planning for engagement with particular groups during the discussion activity.  

And later during the data collection phase I reflected on how the insights from the incoming data may form the background for questions during the final interview:

A brief outline of my thinking so far... there is something coming out that is to do with handing over control to the children, giving them responsibility. I’m not sure – teachers letting go, handing over control – something emerging for the final interview.  

At times, the boundary between the phases of data collection and analysis blurred. Immediately after each lesson the oral diaries were re-played a number of times in order that a written report and full transcript could be created. This process of transcription allowed me to get a feel for emerging themes and note any raw interpretive comments in my research journal.

There were points during the data collection phase when I was able to begin more structured analysis. An early breakdown of the three pairs of initial interviews provided a backdrop for the project and revealed a set of notions about using peer group talk at that point. Details of this breakdown are provided in Appendix 7.1 p.315. It shows that for the teachers, social issues such as involvement, collaboration and the development of confidence through peer group talk were significant, a point congruent with the literature (Alexander, 2000, Alexander, 2008c) and also that they experienced tension with using a group talk approach in science.
After a full term of the project, when two or three lessons had been observed in each classroom, the oral diary data and focus pupil group interview data collected to that point were analysed such that any emerging notions could be identified (Appendix 7.2 p.317). The presence of new notions highlighted to me that there were possibly changes occurring in the ways teachers were thinking during the project. Therefore this early breakdown of data was informative in that it provided one possible focus of ‘changes in thinking’ for later analysis in response to the main research question. It also highlighted a topic for an additional interview question (‘In what ways has your awareness or use of group talk altered over the process of the project?’) in the final phase of the study. The notions identified at these early stages also provided a conceptual platform from which to move when conducting the more detailed breakdown and coding of data at the end of the collection phase.

4.1.2. Initial steps – broad analysis
Analysis is the process of breaking down data in order to find meaning, make sense of emerging issues and answer research questions. With this in mind my first step in the analysis after the data collection was complete, was to revisit the research question; ‘Remain clear in your own mind what you have set out to do’ (Woolcot, 2009, p.34). I created a memo for myself (Table 4-1) with the overarching research aim, question and supporting questions and alongside this added a list of the data sets upon which I would draw in attempting to explore them. I found this chart useful and something to which I returned repeatedly during the analysis phase to ensure that I utilised all of the data sources and keep my thoughts ‘on track’. Inevitably during the process of reading and coding the data many interesting notions bubbled to the surface but I knew that it was important for the sake of validity to keep a focus on those that were related to the aim of the research.

Another useful strategy I developed in an attempt to keep the focus was to insert the main research aim as a temporary header in the Word document. This enabled me to keep seeing the purpose of the research each time I scrolled through my work.
Table 4-1: Overview of research aim and data sets

**Research Aim:** To seek an understanding of the ways in which teachers facilitate productive group talk in primary science

**Main research question:** How and through what processes do primary school teachers engage pupils in productive group talk in science?

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<th>Supporting Questions</th>
<th>Data Production Methods</th>
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<td>Lesson observations</td>
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<td>(22) Emma 8 Arun 9</td>
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After completion of the fieldwork all of the sets of data were reviewed in order to familiarise myself with the entirety of content. Written notes and lists of summarised
content were made. Grids of these summaries were drawn up for each data set in an attempt to identify broad themes and find stories which may guide a more in depth analysis. This type of data reduction is seen as an important strategy for qualitative researchers (Attride-Stirling, 2001) and ‘playing with the data’ in this way can be a fruitful activity (Yin, 2003, p.111). The summary grids created are detailed in Appendix 7.3 p.319. I found that by creating this range of grids, I was able to gain a feel for the terrain of data emerging from all participants. I found them to be a useful tool at various points during the ongoing analysis, serving as a speedy way to connect back with the broad picture when I later became immersed in more detailed work on individual data extracts.

Drawing on the notion of teacher as researcher (Stenhouse, 1975) I also focussed on the teacher participant’s ‘findings’ at the end of the study. From a broad sweep over the final interview data it became clear that the teachers had an appreciation for the power of talk for developing children’s learning. They spoke about their passion, interest and strategies in encouraging talk in the classroom, in creating the environment conducive to it and for the independence talk gave to children. They highlighted the importance of getting children asking questions, inquiring and problem solving in order to help them engage in more productive talk. However it was also evident throughout, that there were challenges and tensions around which they had to navigate when incorporating group discussion in science and that perhaps some of these were inhibiting for their practice.

Creating a summary grid of this data (Appendix 7.12 p.336) helped me begin to express ideas as themes, rather than my more simplistic early organising structure of teacher/children/management. The themes identified from this data summary were (in no particular order):

- Social environment for talk
- Group talk developing science as inquiry
- Group talk as a tool for learning
- Pedagogy of using group talk
- Group talk developing ownership
- Tensions in using group talk
This list became a useful starting point and guide for the ongoing analysis because it enabled me to identify the knotty issues emerging from the data which could be further investigated, for example the theme of tension and that of scientific inquiry. The area of creating a safe social environment for talk is well acknowledged to be a prerequisite for positive group discussion and so I felt, although it was clearly important, it was not an imperative for this project. In addition, the area of ‘talk as a tool’ is one which this study is predicated upon so I did not view it as an area of thematic analytic focus.

The children’s interview data began to reveal that pupils also had very clear ideas about how talk was useful for them and how they would like it to sound, although their ideas were less varied than the teachers. In addition, it became clear from the Exploratory Talk summary and analysis of peer group talk (Appendix 9.1 p.341 and Appendix 9.3 p.344) that children had not engaged in Exploratory Talk in a progressive and improving pattern through the year but that there were episodes of rich group dialogue at seemingly random intervals. My rather naïve expectation had been that it may be possible to identify throughout the year a developing pattern in the pupils’ use of group discussion, due to the reflective teaching model being applied and the regular use of peer group strategies. The process of transcription and production of the group discussion data therefore became a rather uncomfortable process in that it revealed complexity rather than neat and tidy outcomes.

4.1.3. Developing themes – fine analysis

4.1.3.1. First ideas
In probing the data more purposefully to begin to unpick the complexity of the situation, a thematic analysis approach was taken. Before proceeding further, all of the data sets were imported into the software package, NVivo. This was chosen to support the analytical process because it provides an environment in which to store, handle and access large amounts of qualitative data but also because it has the facility
for coding data efficiently and keeping records of ideas, searches and analyses (Gibbs, 2002).

The subject of the first fine analysis was the teachers’ ways of thinking regarding the use of group discussion. This was carried out with the teacher interviews, in order to address the first of the supporting research questions ‘what are teacher’s considerations regarding group talk in science?’ I saw the exploration, description and categorisation of the teacher interview data set and the search for patterns or issues of interest, as a useful starting point for this part of the analytical process. In addition, I thought that the results of this would provide a platform for further analytical procedures in response to other questions.

During the broad analysis of teacher interview data as described in the preceding section, I had identified some possible issues of interest so I began by using these themes as starting points in an organising process (Attride-Stirling, 2001). Looking back at some of the notions collected from teachers early in the study and previously listed, I was able to collect some initial headings as a coding guide. This led to the creation of a hierarchical set of possible headings as an initial framework for the coding process and this is provided in Table 4-2.

<table>
<thead>
<tr>
<th>Overall Theme</th>
<th>Organising Theme</th>
<th>Possible Basic Themes</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ways of thinking about enabling productive talk in science</td>
<td>Pedagogy of using group talk</td>
<td>Including uses and practices</td>
</tr>
<tr>
<td></td>
<td>Considerations, tensions and challenges</td>
<td>Including time and control</td>
</tr>
<tr>
<td></td>
<td>Developing inquiring scientists</td>
<td>Inquiry; independence/ownership</td>
</tr>
<tr>
<td></td>
<td>General approach to teaching science</td>
<td></td>
</tr>
</tbody>
</table>
I translated this into a node tree in Nvivo and the process of detailed coding began with the initial interviews. I coded the entire data set by reading through each item and tagging selections of the transcriptions to a node. Where an idea recurred in any of the items, it was tagged onto an existing node. At points it was necessary to add further nodes to relevant branches of the tree to code for ideas coming from the interviews which had not previously been identified in the initial review, for example ‘Accountability’ and ‘Creativity’. What was particularly noticeable was the extent to which additions were being made to the branch of ‘Considerations, Tensions and Challenges’ and I realised that I would need to watch out that this area did not become too unwieldy and that it may require some refinement. This frequency of coding into the ‘Considerations, Tensions and Challenges’ category consolidated my earlier thinking about the importance of the issue of tensions, which first came to light during the broad stage of the analytical process. I also decided to code for teachers’ general ideas about teaching science, so that I could create a bank of references on which I could later draw for contextual information.

During this process, it became apparent that there were differing ways of reading the data. It was possible to read it just for what was explicit, for example, picking out when teachers described a particular aspect of their teaching as changing or when they made observations about children’s responses to lessons. However, much of the process of reading and coding involved a layer of interpretation, requiring ‘reading through or beyond the data’ (Mason, 2002, p.149) to find implicit meaning. This involved making decisions about the names of the nodes such as when I labelled as ‘Security’ a teacher’s comment about feeling happier in using group discussion because he now trusted the children to come up with outcomes. I also became aware that I was sometimes adding text references to a pair of nodes, for example, Ownership and Independence. Although coding to more than one node is considered acceptable, even good practice, this made me realise the importance of assigning clear definitions as this was part of the analytic process and it would make the coding process more precise. In addition, it was important to consider how much of the text to code; tagging too little may have meant that context was lost upon rereading a set of selections. Through the process I kept a record in the Nvivo software, of the
development of analysis (Gibbs, 2002, p.83); keeping a log contributes to the audit trail of the project and makes for a transparent process. Once the initial interview data set was completely coded, a picture began to emerge about the considerations drawn upon by participating teachers when using group talk in science. Representations of this breakdown are provided in Appendix 7.4 p.320.

What was striking from this analysis was the relative amount of teacher thinking about using talk for the sharing and challenging of ideas; this is in line with the literature (Resnick, 2010). In addition, there are a clear range of considerations that these teachers felt they needed to take into account when incorporating group talk into the classroom in science. These include trying to ensure that children are involved, engaged and collaborating well:

*It’s making sure that everyone as best they possibly can is focussed on what they are trying to do that is a challenge but I think that that goes back to engagement on the lesson and giving them the confidence to talk about what they are investigating.*

*SIMON INITIAL INTERVIEW 1*

*The danger sometimes in group talk and pair talk is that you still get individuals still not talking so you’ll get no matter how you pair them if you’ve got someone confident in talking and someone not confident in talking there is still the danger that the other person won’t talk…it’s just the confidence that they have and that worries me and how to get over that barrier.*

*ARUN INITIAL INTERVIEW 1*

Although the most experienced teacher was apparently less concerned about these issues, just remarking:

*…you do find that there’s sometimes somebody who will just tell everybody what they are doing and that’s it.*

*EMMA INITIAL INTERVIEW 1*

Another reason that emerged about feeling unsure was subject knowledge:

*It is more challenging and also teacher’s knowledge, I mean you have got to know like today… but it is the words, the vocabulary and everything, so you have got to know, that why I was let’s get a dictionary out and see just to make sure that I wasn’t going to lead them down a path that…, so the teacher having all the right knowledge and everything as well is a challenge.*

*EMMA INITIAL INTERVIEW 1*

However, it could be said that this is an issue with teaching science in primary schools generally, rather than it being specific to using group discussion; having strong subject
knowledge is seen to be a major component in the way in which teachers are able to help children develop their learning primary science (Traianou, 2006).

4.1.3.2. Plotting changes
The process of coding was repeated for the final teacher interview data and a breakdown of coding is given in Appendix 7.5 p.322. What came to light from this data is that there were differences between the way in which the teachers considered using group talk at the beginning and the end of the study. This confirmed my early ideas about changes in teacher thinking which had initially emerged during data collection process. Appendix 7.6 p.324 shows how coding frequency reveals some apparent changes in teacher thinking and this theme will be explored later.

4.1.3.3. Developing the picture
The semi structured interviews were not the only data source from which I was able to capture the thoughts of the teacher. Data from the card sort interviews also provided an opportunity to answer the question about the ways in which teachers consider their use of group discussion (Table 4-1). As I began the process of coding these data sets, I was uncomfortable with the notion of working on the transcripts with a predesigned set of ideas from which to search. This is because the activity embedded within this interview technique is designed to elicit individual ways of thinking and therefore it seemed inherently wrong to assign textual references from these transcripts to existing codes. In addition, it also seemed theoretically incorrect to overlay one participant’s elicited ways of thinking onto another’s thoughts. Therefore, because I did not want to prescribe categories for coding, I worked through each of the card sort interviews using a free node coding technique; allowing the coding system for each participant to emerge concurrently with the reading. This choice had the potential to create difficulties because it led to the production of a range of coding systems that would have to be reconciled later. I refer again to this challenge in a later section.

Beginning with the final card sort interviews, I coded each one in turn, reading through them for interesting aspects and tagging each selection of the transcriptions to a new
node, which was then named to denote the concept or idea that the passage represented. When all of the final card sort interview transcripts were coded it became possible to collate a list of the ways of thinking elicited from each teacher participant and this is given in Appendix 7.7 p.325. Using the modelling tool in Nvivo it was possible to manipulate the labels for each teacher in turn and see if I was able to begin to structure them into groups, and in doing so, focus this analysis into themes.

During this sorting task, it became apparent that some ways of thinking related to social factors and their supporting effect on using group talk. For example, ideas about the development of pupils’ collaborative skills, pupil engagement or that group talk provided a safe place for pupils to express their ideas. Of course, there are positive effects on learning from all of these important factors but they have different qualities to other ways of thinking that I had labelled, such as children questioning and challenging each other, developing inquiry skills and reinforcement of knowledge. These labels have a much more specific and direct focus on developing children’s scientific knowledge and understanding and seemed more related to pedagogical practices and the focus of this study. There were other labels which clearly related to concerns and challenges teachers expressed about incorporating group discussion. I decided to label these as tensional as they related to issues which may cause the teacher to feel their ideal notion of practice in this area was under some kind of strain from other factors.

Carrying out this diagrammatic representation process for one teacher provided a model with which to view the remaining two teachers’ ways of thinking node labels. Interestingly, despite having different content it seemed that the other two teachers’ sets of node labels could also be sorted into the same three broad groups: social, tensional and pedagogic. Appendix 7.8 p.326 shows the visual representations of this grouping activity for the final card sort interview data collected from each participant. The initial elicitation interviews from each teacher were then also coded against these established nodes.
4.1.3.4. Drawing ideas together

At this point I became very conscious that in coding each participant’s card sort interview data, I had developed an inconsistent labelling system. I realised that this would make further analysis rather tricky and that I should have utilised similar vocabulary when working, so that I could bring together or compare the ideas coherently. My other concern was that I had developed two different coding systems based on the different interview types. I realised that I needed to find a way to bring together the evidence from these different sources to create a master code structure if I was going to be able to see a coherent picture. A detailed description of how I went about this process is given in Appendix 7.9 p.328 and a visual representation of the outcome is given in Figure 4-2 below.

The coding frequency (Appendix 7.9, Table A7.9b p.332) for these ways of thinking demonstrate that there are some notable themes for further exploration, in particular scientific inquiry; children sharing and challenging each other’s ideas and developing understanding; pupil independence and ownership and also tensions related to control.

4.1.3.5. Consulting colleagues

At this point in the analytical process, I took the opportunity to consult with my fellow Special Interest Group members. I described my process of thinking and thematic analysis and presented the list of node labels for pairs to classify into a map. This process was useful in that it helped me to clarify what I had done to this point and define the coding labels carefully in order to explain to the group but also because it was interesting to see how others may group items. A range of very different classification maps were created by the pairs but interestingly ‘constraints’, ‘challenges’ and ‘teachers’ considerations and control’ came up as headings within maps, showing some similarity with one of my themes. The group made the point that it would be interesting to look for a story of each participant over time and also highlighted the importance of now drawing on the pupil data to make a more complete picture.
Figure 4-2: Master map of teacher ways of thinking from all interview data
4.1.3.6. Looking at pupils’ ideas

From the initial broad review of all of the data before the coding process, what emerged from the children’s interviews was a sense that they valued having time to share their ideas; that they gained from discussing science with others in a group, especially when challenges, problems and investigation were involved. The detailed coding process was conducted with the data from the series of post lesson, pupil group interviews in each setting. This phase of the analysis enabled me to create a picture of the kinds of beliefs and considerations the children in this study drew upon when thinking about using talk in the classroom.

In the same way as I had conducted the coding exercise with the teacher data, I began to code the pupils’ interviews, searching for segments of interesting, meaningful data in order to collect evidence of the range of their ideas about using talk in science. I made sure that the codes emerged from the children’s data in order to produce an authentic picture; however, as appropriate, I was very careful to utilise the same language as in the teacher’s coding system. When I began to code the interview data from the second setting, I used the basic code system which I had developed with the first, adding nodes where necessary. After coding the entire children’s interview data set a wide range of ideas about using talk were in evidence. A ‘macro’ representation of all of these ideas across all three settings was constructed as a tree diagram in Nvivo and this also shows the relative occurrence of each idea. This representation is given in Appendix 7.10 p.334.

What was immediately clear from the analysis is that as with the teachers, the pupils considered group talk as a place to share ideas. On review of the textual references, it seemed to be that pupils generally view the discussions rather simplistically, as a way of collecting knowledge from others, finding out, perhaps seeing themselves as factual magpies; they also seem to use the discussion as a way to get help. This idea will be explored in a later chapter.

Using the modelling tool in Nvivo, it was possible to collect the children’s ideas together in a similar way to the teachers, using the five broad groups again (Appendix 7.11 p.335), although the groups were not as well populated compared to the
Figure 4-3: Ways of thinking map created from pupil interview data
teacher’s model. This is particularly apparent with the tensions area, which was significantly more limited. A master map of pupils’ ways of thinking collated from all interview data is given in Figure 4-3.

4.1.3.7. Overview
From the analysis to this point, what has been established is that teachers have a wide range of considerations when thinking about group talk in science. Participating teachers’ ways of thinking form around social, pedagogical, cognitive and scientific themes however, tensions also permeate through their considerations. In addition, pupils hold a range of views about their science learning through talk; this range is not as wide as teachers’ but can be organised around similar themes. Some aspects of these themes appear to be prioritised by the teachers and these are areas for further exploration:

- Scientific - Scientific inquiry
- Cognitive - Children developing understanding; sharing and challenging each other’s ideas
- Social - Pupil independence and ownership
- Tensional - Tensions related to control and security

4.1.4. Exploring themes – temporal analysis

4.1.4.1. Looking at changes in thinking – starting at the end
During the phases of analysis, apparent changes to teachers’ ways of thinking about using talk had become evident. This led to the development of a final interview question, which required the teachers to explicitly reflect upon changes to their ideas about and practices of using peer group talk in science. Looking at the participants’ responses it was possible to develop some broad categories (Table 4-3) and these can be considered as change themes (Shapiro, 1996). These change themes consolidate earlier indicators from the thematic analysis, highlighted in the previous section, which also suggest directing a deeper exploration of teacher thinking about talk, towards ideas around scientific inquiry and pupil ownership.
Table 4-3: Change themes as identified by participants

<table>
<thead>
<tr>
<th>Changes in thinking and practice as specifically identified by the participants in final interview</th>
<th>Change theme label</th>
</tr>
</thead>
<tbody>
<tr>
<td>Using talk for children to:</td>
<td></td>
</tr>
<tr>
<td>1. Be independent and have ownership over learning</td>
<td>Pupil ownership of learning</td>
</tr>
<tr>
<td>2. Focus on scientific inquiry process; ask questions, work practically and solve problems</td>
<td>Scientific inquiry</td>
</tr>
</tbody>
</table>

The literature informed the process at this stage. The review of teacher belief research had revealed the importance of epistemological beliefs, beliefs about teaching and learning and science itself and it was interesting to note that the change themes identified could be aligned to epistemological beliefs:

Figure 4-4: Identified change themes of teacher thinking and their relationship to broad categories of epistemological beliefs (identified in literature review)

<table>
<thead>
<tr>
<th>Teacher thinking about using group talk in science:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Pupil ownership of learning......................................... Belief about learners and learning</td>
</tr>
<tr>
<td>• Scientific inquiry................................................................. Beliefs about science teaching</td>
</tr>
</tbody>
</table>

4.1.4.2. Next steps

In order to look more closely at the change themes in teacher thinking across time a further layer of analysis was undertaken. A chronological account of each teacher’s thinking was created, using all of the observation, oral diary and initial and final interview data sources so that a complete picture for each participant could emerge across time. Creating chronologies is a frequently used technique in case study which focusses on its strength to trace events over time (Yin, 2003). These chronological accounts were then analysed and broken down in a more deductive fashion, coding to the change themes identified.

It was during this process that I became a little disillusioned with Nvivo software. I found that I was struggling to see the story when all the data was held in the package. I made the decision to work with hard copies of the data at this point, re-analysing for
the change themes by highlighting and cutting up segments of the chronological accounts one by one, creating piles of data extracts as evidence for the developing story.

Finally, I then reviewed pupil interview and group discussion transcripts looking for evidence of the impact of developing teacher thinking. Through this repeated process of searching through data and picking out in more detail where I could identify reflections on ideas about ownership and inquiry in teaching and learning, the evidence was reviewed in the light of themes which had emerged from the initial analysis, this activity being part of the ongoing organic process of coding (Braun and Clarke, 2006, p.91).

In addition to the thematic analysis, just described, a further layer of systematic analysis was applied to the peer group talk transcripts (Appendix 9 from p.341). Details of this process are outlined in the following section.

4.2. Discourse analysis of peer group talk

The peer group talk collected during the study was subject to analysis which occurred in parallel with the inductive process previously described. There are many ways of analysing talk, each with distinguishing characteristics. Conversation analysis focuses on turn taking, sequences, fragments of utterances and other minute features of language in interaction (Cole and Zuengler, 2008), involves a micro-analysis of recurring patterns of talk and views talk as language in interaction (Wooffitt, 2005), whereas discourse analysis views talk as language in use (Rex and Schiller, 2009). For the peer group talk, Sociocultural Discourse Analysis (SCDA) was used (Mercer, 2004). It was chosen for its concern with learning outcomes, the function of language and the way dialogue, taken as a form of intellectual activity, is used for the development of thinking (Mercer, 2004, p.141). Further to this it also seeks to explain how shared understandings are constructed. This type of analysis integrates both qualitative and quantitative methods. Table 4-4 provides an overview of the process of analysis of peer group talk.
### 1. Analysis during transcription

By listening and re-listening to the children’s collaborative talk, an inevitable part of the transcription process, I was able to gain an immediate insight into the kinds of talk the children were using and its quality, for example where it was disputational, cumulative or exploratory in nature (Mercer, 1995). I was able to broadly identify and note lessons where more productive talk took place (Appendix 9.1 p.341). In this way, the actual transcription of children’s group discussion was not a neutral administrative exercise but an interpretive act (Bird, 2005); a chance to gain an initial understanding of the nature of the talk.

### 2. Quantitative analysis

Quantitative methods can reveal the quality of interaction and how this changes over time. This analysis was conducted in order to consolidate initial ideas about where productive, exploratory peer group dialogue had taken place and also to see if there was some trend in the use of talk by the groups. Appendix 9.3 p.344 details an overview of this analysis and the results.

Although this type of quantitative analysis is very broad brush it does provide a way to gain an overview of the productivity of the talk used by the peer groups during the project and pick out lessons of note and worthy of qualitative investigation. In this way, the quantitative data is ‘an aid to understanding the broad qualitative data and not as a means to reduce the data to a numerical tally’ (Knight and Mercer, 2015, p.309).

### 3. Qualitative analysis

Qualitative methods can reveal ways in which language is used as a tool for collective thinking and learning. The analysis of the talk proceeded at a range of levels (Mercer, 1995); a linguistic level and at a psychological and cultural level which together provide a commentary upon the thoughts and actions of the pupils and how much they entered into an ‘educated’ discourse (Mercer, 1995). I proceeded in the following way:

- Features of productive Exploratory Talk (Appendix 9.2 p.343) were identified within the transcripts. This provided a tool to break down the data and understand the quality of talk occurring specifically in the episodes highlighted as productive through the quantitative analysis. Appendices 9.4, 9.5 and 9.6 provide an analysis of talk types that were captured during the study,
categorised as disputational, cumulative or Exploratory (Mercer, 1995).

- The theoretical construct of the Intermental Development Zone was then applied to selected examples in order to interrogate the dialogue and understand the ways in which teachers had enabled productive group talk (Appendix 9.6b p.364).

- I also added a further layer to this analysis, drawing upon the observation and oral diary data collected around the selected examples. This looked at teacher thinking and action and its impact upon the productive talk. The results from this final part of the analysis contribute to the findings presented in Chapter 7, which centres on tensions and challenges in using peer group talk.

The discourse analysis allowed me to gain structured understandings of the peer group talk emerging within the lessons and it could be considered alongside the thematic analysis. The two change themes identified through the thematic analytical process described in Section 4.1, are presented in Chapters 5 and 6 through the exploration of a wide range of relevant data extracts. The data supporting the theme of tension in teacher thinking which was identified through the thematic analysis is presented in Chapter 7. The theme of children sharing, challenging and developing their ideas is also explored within Chapter 7. Extracts of peer group talk and associated analysis support the presentation of the thematic analysis.
5. Changes in Teacher Thinking: Pupil Ownership – an aspect of Constructivist Learning
5.1. Introduction

Despite the differing starting points and belief sets of the three participant teachers and the differing ways they provided learning opportunities for their pupils, themes appeared to emerge from both the coding stages of analysis and through explicit recognition by teachers themselves when asked about how they had changed the way they worked with peer group talk over the course of the project. This suggests that through the use of peer group talk in the classroom teachers began to reconsider their implicit epistemological positions. This chapter will focus on the way in which the teachers thought about how to facilitate peer group talk; how this developed over time to focus on enabling pupils to be independent scientists and the concomitant feelings of tension. The impact of the changes in teachers’ ways of thinking upon the participating Year 4 pupils’ perspectives and experiences of science and the learning enabled will also be considered.

5.2. Beliefs about learners and learning - pupil ownership of learning

Through their consideration of the use of peer group discussion, all three teachers focussed upon constructivist notions around handing over responsibility and ownership to the children. Classroom dialogue can be understood as a site within which pupil ownership and agency can be validated or denied (Arnold and Clarke, 2014) and beliefs about the role of the pupil and how they learn science have been identified as an important influence on the teaching of science (Anderson, 2015, Bryan, 2003, Friedrichsen, Driel and Abell, 2011). A range of literature was consulted in order to sharpen my focus and formulate a broad working definition of ownership of learning in terms of teacher and pupils (Enghag and Niedderer, 2008, Martin and Hand, 2009, O’Neill and Calabrese-Barton, 2005, Rainer and Matthews, 2002) (Appendix 10.1 p.390 and Appendix 10.2 p.395). This working definition provided useful theoretical guidance for the deductive analysis of data for this change theme. The following sections show how each teacher demonstrated epistemological beliefs related to the role of pupil and their ownership of learning and also how these shifted over time. Beliefs which are discussed were both espoused and more tacit, the latter

5.2.1. Emma

5.2.1.1. Initial espoused beliefs

During the interviews at the outset of the study, when asked about the important factors to consider in thinking about science learning, Emma focused immediately on the importance of relating science to the children, to:

...make it meaningful for them so it’s not just a separate subject that is nothing to do with them, it starts from what they know.

EMMA INITIAL INTERVIEW 1

You can teach without the talk but it is not as meaningful to the children than if they are participating, asking questions, sharing answers, challenging each other.

EMMA INITIAL INTERVIEW 2

In addition to this acknowledgment of her desire to be attentive to prior experiences in order to connect pupils with school science, she began to explore how she drew on children’s ideas elicited through group discussion:

...you need to find out what they know already...erm at the start of the topic there will be a talking session where we find out what the children know already ... which then gives me an idea of where to go.

EMMA INITIAL INTERVIEW 1

The focus here is on eliciting children’s prior knowledge through talk, in this case framed for assessment purposes; for Emma to find out what children know already so that she can plan content, questions and resources which relate to children’s existing ideas (Baviskar, Hartle and Whitney, 2009). Emma went on to share how she provided the dialogic space for children to contribute further and that this opened up a channel through which they can influence the direction of learning in the classroom:

If they have something to add to what they say I just kind of go with the children then and what they say...I also ask them in their groups to come up with what they would like to find out during the topic.

EMMA INITIAL INTERVIEW 1
These beliefs relate to the use of constructivist approaches in science which ideally for Emma provide opportunities for children to be active in the learning process (Harlen, 2007). The process of starting with children’s thinking is the bedrock of constructivist approaches and the ‘received wisdom’ of training programmes (Waters-Adams, 2006, p.926).

Another important priority espoused by Emma was to use group discussion as an opportunity for pupils to discuss their ideas:

*... to share what they know, change what they know and build on what they know.*  
**Emma Initial Interview 2**

The way she talked in this short extract places responsibility for action firmly with the children and this demonstrates constructivist beliefs about children being active participants in the learning process (Prawat, 1992). She also mentioned how group talk provides a space for even the usually quiet children to contribute and believed that pupils should view one another as a resource:

*...getting them to learn from each other, so that I am not challenging them they are challenging each other so they are more likely to learn from each other than they are from me really, so if their friends or someone on their table explains it to them, that’s as good a way..... yes, it’s powerful because it is somebody their age, it’s not the knowledge person, it’s ooh they know that and then they can find out from each other...it’s very much I’m not the person with the answers, you’ve got to listen to each other.*  
**Emma Initial Interview 1**

Emma also seemed to frame peer group talk as an activity with the potential to hand over responsibility for learning to pupils, enabling them to be ‘part of the lesson’ and therefore active in the learning process, making their own links between ideas:

*If they have talked about it... they have done a lesson really, it is not just me standing up talking to them, telling them the facts, so yes and then they will remember it more because they have done it and hopefully they will make the links more because they have done it...if they had discussed it then it would stick more in their mind I believe, than if I just say this is this and that is that.*  
**Emma Initial Interview 2**

*Although it’s a bit scary it’s also worthwhile because it sticks with them and they understand it more than if I had just stood there and told them.*  
**Emma Initial Interview 1**
Another interesting dimension to Emma’s initial beliefs about using talk was the focus she placed upon trying to get children to understand how they use it:

*I would just say that it is all very well doing all this talking but without discussing what you have come up with and reflecting on it and looking at how you have changed your view that is really important too ... so that they learn from everything that we do...it is really key to the cycle of learning.*

**Emma Initial Interview 2**

Emma demonstrated here a belief that children need to develop metacognitive understandings, begin to know how to use talk and reflect upon its purpose and potential for learning and in doing so regulate themselves in the process of group discussion (Schraw, Crippen and Hartley, 2006). This way of working acknowledges that learning is a social process within which pupils are active participants (Rojas-Drummond and Mercer, 2003, Mercer, Wegerif and Dawes, 1999, Webb, 2009). Along this vein, in a different interview she discussed how she taught ground rules for talk (Dawes, Mercer and Wegerif, 2000) and tried to develop a culture of talk to help children utilise it purposefully - to share ideas and challenge each other:

*...looking at a person who is talking, nodding your head and reacting to what they are saying, all those things...we go over the rules, how do we do this, how do we make sure we understand, what do we do if we don’t agree and how do you challenge somebody, do you go ‘you are wrong’; get all those rules sorted and really just affirm them each time.*

**Emma Initial Interview 1**

These data from the initial interviews demonstrate that at the outset of the study Emma espoused strong constructivist beliefs about the power and utility of peer group talk in science for helping foster pupil ownership of learning in her classroom.

However, even at this early stage of the project Emma’s interviews revealed how such ideals about using peer group talk were at times placed under tension by other beliefs related to contextual and curriculum constraints (Fang, 1996, Jones and Carter, 2009). During a later part of the interview she again talked about how experience had taught her to let children go and give time for sharing ideas but this time there was a caveat:

*...just go with them...it means more to them, they are going their own way if that makes sense. It’s more challenging. It is really hard because you want you know you have got to get these concepts across, you have got to, they have got*
5.2.1.2. Beliefs in practice

During the second observed lesson, through her practice Emma demonstrated some of her espoused beliefs about children taking ownership of learning. The lesson centred on children developing their ideas about the human skeleton through the diagrammatic representation of their current collective thinking. Emma connected the lesson to children’s previous experience by introducing the task with a sharing of personal stories of broken bones and x-rays and when a child asked the question ‘do hands go floppy when bones are broken?’ she didn’t answer herself but asked the class for their ideas. It was clear that Emma was practicing her beliefs by encouraging and using pupils’ contributions and also that pupils felt comfortable to interject with their own wonderings as they emerged. There were high levels of peer group talk time and pupils had access to a range of ideas as they moved around the room to ask questions about other groups’ diagrams during the second phase of the lesson. Emma positioned herself as a listener to group discussions, occasionally making comments or asking questions. She encouraged children to work collectively and draw on one another’s ideas through a reiteration of ground rules and the provision of only one pen so that pupils couldn’t complete parts of the diagram on their own. Emma led a reflective plenary focussing on how the children had used talk, picking up examples of sharing ideas and questioning.

This lesson sat in contrast to three other early lessons where talk was more tightly controlled by the teacher. From the peer group talk time data (Table 5-1) for lessons 1, 3 and 4 it is clear that pupils were not given as much freedom to talk together however when Emma led the whole class discussions she worked dialogically, requiring pupils to participate, drawing on their ideas, exploring an individual’s thinking and asking the class what their response was. She often synthesised pupils’ thoughts to create a type of collective understanding (Edwards and Mercer, 1987) and this whole class teaching was punctuated by episodes of small group or talk partner work. These were often short and had strictly defined parameters (Tobin and Tippins,
and seemed to be designed as spaces for children to collect thoughts together to feed into ongoing teacher led dialogue.

Table 5-1: Table of talk time in Emma’s lessons

<table>
<thead>
<tr>
<th>Lesson</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lesson time (mins)</td>
<td>60</td>
<td>60</td>
<td>50</td>
<td>90</td>
<td>90</td>
<td>55</td>
<td>60</td>
<td>60</td>
</tr>
<tr>
<td>Total group talk time (mins)</td>
<td>7.5</td>
<td>41</td>
<td>8.5</td>
<td>14.75</td>
<td>59</td>
<td>16</td>
<td>17.5</td>
<td>23</td>
</tr>
<tr>
<td>% of lesson for group talk</td>
<td>12.5</td>
<td>68</td>
<td>17</td>
<td>16</td>
<td>66</td>
<td>30</td>
<td>30</td>
<td>38</td>
</tr>
</tbody>
</table>

An example of this occurred during lesson four, which focussed upon how the temperature of hot water changes over time. The groups were asked to first discuss their predictions around what may happen to a cup of water when left out and ideas were shared as a class. They were then asked to discuss and create a plan for how they would carry out a test to investigate the phenomenon. However, the children did not have the opportunity to carry out their plans because as the lesson progressed Emma was herself demonstrating the phenomenon; the group talk tasks punctuated whole class episodes of prediction and measurement of the water sample and discussion of what was occurring. What became apparent was the task set for groups was essentially futile; they were discussing and planning for what they were in fact witnessing. Interestingly, in her reflection after the lesson when initially prompted to think about how the group talk had gone, Emma instead referred entirely to the whole class talk and how pleased she was with it. It wasn’t until further prompting about the specifics of the groups that she began to explore what had happened within that forum. When talking about her plans she said ‘I wanted them really every step of the way to talk’ but later perhaps suggested that she wasn’t so sure she had achieved this, that the lesson was ‘me talking a lot but I think I give them time to talk which I think is valuable...I want them to be ready to do it themselves next time and I think if I keep giving it to them they are not going to make that step.’ EMMA ORAL DIARY 4

The focus on whole class, teacher directed talk here in both her reflection and in practice indicates that although Emma espoused strong beliefs about the value of group talk for ownership of learning, they were not enacted and she in fact
experienced tension from the apparent desire to control the dialogue and to get to the correct outcome in the time allocated (Tobin and McRobbie, 1997, Pimentel and McNeill, 2013, Baviskar, Hartle and Whitney, 2009, Mansour, 2009) and this created ‘cracks’ in her social constructivist pedagogy (Orland-Barak, 2003). Data from post lesson interviews suggest that pupils appreciated that talking was helpful and that their peers were a resource for their learning, however when asked, perhaps unsurprisingly they identified the whole class parts of the lesson as where they had learned most:

**Sam:** the class because I had I put my hand up I had sort of an idea and then they like someone else kind of had an idea that went with mine and then it got me thinking to like a better idea

**Ali:** when we were a talking about the equipment ... we talked together and thought of our own idea and if we disagreed we can change our ideas...other people around if somebody told you something and you didn’t know it you can be like oh I know that now and pick it up from other people

**Nathan:** you could put your ideas together

**Ellie:** I learned the most in like the equipment like to know like which bits not what things not to use... when they were talking about like something I didn’t know and I learned from them

Some of them also felt suppressed by Emma’s approach and it seems it had not escaped them that most of their group discussions had no real purpose, that through it they held no real power to shape the direction of classroom activity:

**Harry:** I didn’t really get to do anything all I heard was the teacher. I was only listening erm I like to do things more than listen

**Sam:** too much of like explaining I wanted to more like work more... have more challenges

These comments seem to suggest that the children wanted a deeper involvement in learning than the short peer discussion had provided (Rudduck and McIntyre, 2007, Pedder and McIntyre, 2004). A dissonance had emerged between the different participants’ perspectives and pupils perhaps felt that they were not in fact active partners in their learning as Emma had hoped for; they did not feel that they had ownership of their learning because they were not working in the way they valued and there was a sense of frustration with the teacher’s control of the discourse (Rop, 2003,
Fisher and Larkin, 2008, Myhill and Warren, 2005). These pupil contributions to the project had an impact upon Emma’s ongoing thinking about her use of peer group talk resulting in less inconsistency between espoused belief and practice as will be underlined in the following sections.

Emma’s espoused beliefs about using group talk to enable pupils to take ownership of their learning surfaced explicitly in a striking fashion during the fifth lesson, where she provided opportunities for the children to construct and carry out their own investigations. The lesson followed on from one the previous week which had aimed to develop pupils’ ideas about preventing heat loss (not observed) where Emma had set up an investigation to show certain materials, particularly bubble wrap they concluded, can keep things warm. During the observed lesson (lesson 5), the groups were charged with considering which material would act as the most effective thermal insulator for an ice cube and they were required to discuss, plan and conduct their own investigation, make decisions about resources and measurements in order to answer the question. This lesson appeared to mark a significant moment during the project for Emma; as has been previously mentioned, three out of the four lessons prior to this had been dominated by teacher led whole class discussion and it is clear from the analysis of talk time (Table 5-1) that during lesson five the children were provided with a lot more opportunity to share their thinking with others.

Emma described an altered approach in this lesson, one which incorporated a more active and independent role for the children as they carry out their own inquiries:

*I said I’m going to let you decide... I kept my nose out I think. The hardest thing was not to get involved but at the same time not to let them go off at the totally wrong tangent... that was the critical thing. The fact that they knew they had to do it and they were on their own and that it was okay to make that, I think that was the critical thing because that allowed them, gave them the freedom to talk about it and to come up with their own ideas, rather than straight jacket them into something. That actually gave them the freedom.*

**EMMA ORAL DIARY 5**

Emma stated that she was ‘more aware of not talking too much’ based upon the children’s interview after the last lesson, where they had expressed a desire to talk and work by themselves, without so much teacher talk. The fact that Emma listened
and responded is perhaps evidence for her belief in agency for effective learning in science, where pupils are positioned as responsible and their thoughts taken seriously and acted upon (Arnold and Clarke, 2014).

After this fifth lesson, during the interview with the children, what came through strongly was the pleasure of ownership of the inquiry; it made them feel as if they were doing science, not just learning about it but constructing it for themselves and being responsible for it:

*Sam:* we got to make our own science ... we got to decide what we did the science what we had to do instead of having to follow instructions and do that and you get to make your own

*Yvonne:* I sort of felt like I was a teacher

*Nathan:* we did our own science

*Harry:* we could just get on with it she wasn’t just saying that it could be like you have to do it like this you have to do it like that. We could just do what we wanted to

*Ellie:* I’ve never done it like that before. I actually did it with the group. All by ourselves

There was an air of excitement and surprise during the interview; a feeling that it was a transformation for them in terms of the experience they had been given. Yvonne’s comment is perhaps interesting in that she used the analogy of the teacher to demonstrate the measure of control and ownership she felt she had. The pupils clearly appreciated making their own decisions, controlling their own inquiry into insulating materials. The part of the lesson that the children felt they learned the most in was the time when towards the end they were asked to share with other groups – observing what others had done, listening to their interpretations and results. They said that they learned when being questioned by peers about their own investigation – when they had to explain their methods, decisions and interpretations of evidence in their own inquiries. This is perhaps an indicator of the ownership they felt over their work, that they felt actively involved with it, had constructed their own ideas and were therefore comfortable discussing them.
The discourse analysis presented in Appendix 9.3 (Table A9.3a p.345) revealed that this particular lesson also showed productivity in terms of the number of features of Exploratory Talk. In this next section I will present some of the peer group dialogue which was recorded as pupils set up and discussed their work in this lesson. The extract (see Transcription Box 5-1) begins after the group had collected small cups to hold a piece of ice, had chosen their insulating materials (bubble wrap and tinfoil) from the selection provided and were wrapping the cups with insulation. The teacher happened to be passing.

Transcription Box 5-1

Sam: won’t the heat come in
Nathan: when it gets to five (referring to deciding when they will observe the ice cubes for melting which they had just been discussing)
Sam: the heat won’t it get in from out the glass well I don’t want to cover it ‘cos then you’ll trap the air in
Harry: yea so let’s yeah
Teacher: so you’ve got a decision to make
Nathan: put it round
Sam: we could do the same test with both ways
Nathan: but we thought the tin foil would do it
Harry: no
Nathan: or bubble wrap
Harry: yea the bubble wrap

Sam questions the ongoing wrapping strategy, drawing on the groups’ common knowledge about heat being kept in by bubble wrap and upon hearing this, Emma does not intervene other than to highlight to the group that they must make a decision, firmly placing ownership of the investigation with the group. Nathan suggests an alternative which Sam takes up, thinking that they can test out the idea by trying both covering and not covering the cup, however doubts are expressed and the group end up placing two different materials around and under the cups not over. A while later after they have placed the ice cubes in their cups the group again make their own
decisions about measurement and recording although for one group member perhaps confidence is waning (see Transcription Box 5-2).

Transcription Box 5-2

Nathan: *is this a good idea what we are doing to the ice cube*  
Sam: *every five minutes or every ten*  
Nathan: *shall we do five*  
Harry: *let’s write something over here like every ten minutes equals not melted*  
Nathan: *yea good idea*  
Sam: *then like a scribbly line for melted*  
Nathan: *shall we show Mrs Z what we are doing like so she knows*

At this point the group pauses and no one speaks until Nathan offers another comment as he puts his fingers in the cup:

Nathan: *I think ours is best it’s quite cold*  
Sam: *that’s ‘cos its ice*  
Harry: *that’s pushing the hot air in*  
Sam: *yea you don’t want that*  
Harry: *or it keeps the cool in*

The group pause, have a brief exchange about not breathing over the ice and then Sam seems to draw on Harry’s idea about cool being kept in, changing his mind about having a cup set up with a covering:

Sam: *we can put the bubble wrap over*  
Harry: *oh let’s put one over them let’s try one over them*  
Sam: *don’t let*  
Harry: *let’s put a few scraps a bit of tin foil over a bit of bubble wrap over the bubble wrap hey let’s put them*  
Sam: *we’re supposed to put one over the bubble wrap*  
Nathan: *we’re it doing it now*  

Although the group do not refer to this set of cups again in their dialogue it seems they feel able to move off in an additional direction in an attempt to test out their ideas, demonstrating a feel of autonomy over learning processes (Enghag and Niedderer, 2008). At a point in the lesson when ice cubes were melting Emma set the groups the task of thinking through their reasons for decisions and recording them. This naturally gave rise to a lot of justifications from the children (see Transcription Box 5-3) and the
group are able to do this with coherence because they have a shared prior knowledge of what an insulator does, established in a previous lesson.

Transcription Box 5-3

Harry: *we put it on the bottom because*  
Nathan: *I know why because*  
Harry: *we changed because we changed ours we put it on the bottom we put it on the bottom*  
Nathan: *we thought if we put it over the top it would get more heat in and it would melt quicker so there’s a point*  
Harry: *erm so we put it on the bottom because if we put it on the top it would have melted*  
Nathan: *because it gets it traps the heat*  
Harry: *yea*  
Sam: *mm alright*  
Sam: *because we didn’t want to trap*  
Harry: *didn’t want to trap the tea inside*  
Sam: *the heat not the tea didn’t want to trap the heat inside*  
Harry: *we selected the bubble wrap because we thought the bubbles would*  
Sam: *the bubble wrap because the bubble wrap would hold the heat in*  
Sam: *the bubble wrap was best at keeping the hot water hot*

They return to this topic after measuring their ice cubes:

Sam: *we selected the bubble wrap because we got the ice to make it colder*  
Nathan: *make it cold*  
Sam: *and keep it cold cos it’s already cold*  
Harry: *make it cold keep it cold*  
Nathan: *we used them last week and we and what else we used them last week*  
Sam: *because last week they were the best insulator*  
Nathan: *yea*  
Sam: *they were the best at keeping erm*  
Harry: *warm*  
Sam: *warm at keeping hot water warm*

This talk demonstrates that the group have a common frame of reference within which to work and this enables them to work independently and talk purposefully when Emma hands over responsibility to them (Mercer, 2000); they even begin to tease out their precise understanding of the function of insulators. Finally as the boys are beginning to finish and their ice cubes have survived longer than some others
around the class, they appear to be quite proud of their investigation (See
Transcription Box 5-4).

Transcription Box 5-4

| Nathan: I came up with this idea |
| Harry: no you didn’t |
| Nathan: yes I did well me and you and you didn’t we |
| Sam: we did |

What these extracts indicate is that when Emma placed the peer group in a situation
where they had to make decisions, they responded by engaging in reasoned dialogue
that held justifications and questions and crucially they also made a connection with
their common understandings about insulation which had been previously established
in earlier lessons. In enacting her belief about pupil ownership of learning and handing
responsibility to children, Emma facilitated productive dialogue between the children.

At the outset of observed lesson seven Emma told the children that during the session
she was going to require them to come up with their own questions for an inquiry
centred on dissolving, a concept they had been working on over preceding weeks. The
plan was that they would do this in their small groups, discussing what their questions
could be and coming to some sort of consensus. Although Emma had asked children to
plan investigations in earlier lessons this was the first time she allowed them to
formulate their own questions, a feature of handing ownership to pupils (Enghag and
Niedderer, 2008). In fact the children were so enthusiastic that after a short
introduction they began to vocalise their questions in the whole class forum and
Emma did not send them into their small groups for this activity, despite her plan and
she reflected upon this afterwards:

I'd actually planned for them to talk to each other in groups and come up with
the questions, but they'd actually, because of the talk we were all having, they
were coming up with their own questions, so I changed the plan there so that
they shared them there and then rather than and they were all sparking off
each other then, weren’t they I didn’t really want to stop them.

Emma Oral Diary 7
The groups were however later asked to discuss a plan for how they would like to conduct their investigation. After the lessons Emma reflected on her action and the positive way in which the children responded seemed to surprise her:

*I said to them I’ve not taught like that before and thought I’d just see what questions they could come up with and I was a bit unsure whether they would come up with them and then they came up with questions before I even asked them to come up with questions, they started asking questions…I think it just shows how they’ve grown with their science and how scientific they’re being.*

_Emma Oral Diary 7_

When reflecting upon her hopes for the peer group talk opportunities she had planned for the lesson Emma emphasised pupils being encouraged to take control of the direction of their learning and using each other as a resource:

*I was just, go on, go with it, what do you think, we could try that, how could we try and I was encouraging them to do that, so it gave them the courage and the opportunity to almost fly with it, if you know what I mean, to just have a go and learning from each other just every time, learning from each other I think is what they were experiencing, because I’m trying not to give them the answers…so experiencing the ability to question in science and to justify what they think and link it on to what they’ve learned already._* 

_Emma Oral Diary 7_

Pupils reacted excitedly to the autonomy they had been given and Ellie’s comments in particular seem to demonstrate that Emma’s actions have enabled an active engagement:

*Ellie: we got to plan and like we are going to make an experiment on our own without Mrs Z telling us what to do

Yvonne: a real science lesson

Sam: we got to plan what we are going to do and that it was exciting

Ellie: cos it was like telling us to like try and think that out so we can try it and that has given us questions to think about and then you can find the answer

Emma Pupil FG Interview 7_

During the final interviews Emma made reference to this particular lesson as one which she felt had been most successful and she reiterated her beliefs about the power of group talk to foster in children a sense of ownership:

*The questioning, getting them to come up with their own questions, that’s something that I’m developing more and giving them that control in the science...*
lesson, so letting them talk about it and come up with it without me coming in and saying no, you can do that, you can’t do this and everything like that, that’s something I’ve developed more and more and become more confident about doing through this process and it’s because of the reaction they have to it as well that sort of spurs you on to do that.

...they are able to talk to each other about things and make their own decisions, come up with their own plans...

...through that discussion then they’re coming up with questions, so they’re leading their own learning.

What the data presented here indicate is that at the outset of the study Emma had a strong set of espoused epistemological beliefs about children’s ownership of learning but that there was some inconsistency with the way these were enacted (Fang, 1996, Phipps and Borg, 2009, Jones and Carter, 2009). Through consideration of how she may best foster productive group talk in her classroom and reflection upon pupils views about their learning opportunities, her practice seemed to become aligned more strongly with her constructivist beliefs and this had an impact upon the children’s experience of science learning. This process however, was not smooth and seemed to play out in a context of needing to retain control.

At points, Emma highlighted that by having access to the children’s talk and interview transcripts after each lesson, she had been able to think about how pupils interacted and also understood their own learning through talk. She felt that this process had informed her practice:

They encouraged me I would say. Sometimes you know if you want to do an outstanding lesson you want everyone to be involved and you want the pace to be moving on and sometimes you sacrifice things like talk time in order to get through the lesson and get the learning done and to give your learning to the children whereas the transcripts helped me to see that it is important and they can get the same things from the lesson what I would have taught them but they are getting it from each other with a little bit of me to back it up or lead them in a certain way.

I think was right at the start when we’re doing the talking, how useful it was to the children having had the transcripts and things back, how they really valued being able to talk to each other and then being able to talk to the class about things that just made me want to do it more rather than just disregard it... what the children have said, that’s made me just adjust things and try something new, but it’s given me the courage as well to try something new, so and to build on what we’ve been doing.
Although the first extract demonstrates further the contextual tensions which may create incongruence between belief and practice (Fang, 1996, Phipps and Borg, 2009, Jones and Carter, 2009, Abd-El-Khalick and Lederman, 2000) and affect the application of classroom dialogic strategies, what it also shows is the influence of the transcription data upon Emma’s thinking. They became rather like a reflective provision which nourished existing beliefs about the importance of peer group interaction for ownership of learning and afforded the strength to experiment with classroom action (Schon, 1983).

Table 5.2: Overview of Emma’s beliefs about pupil ownership (those in bold were not elicited at the start of the study)

<table>
<thead>
<tr>
<th>Emma’s beliefs about group talk related to its potential for fostering active learners with ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer group talk:</td>
</tr>
<tr>
<td>• Encourages active participation</td>
</tr>
<tr>
<td>• Provides opportunities for pupils to discuss their own ideas</td>
</tr>
<tr>
<td>• Enables children to become resources for one another</td>
</tr>
<tr>
<td>• Provides spaces for everyone to contribute</td>
</tr>
<tr>
<td>• Gives responsibility to children for questioning each other</td>
</tr>
<tr>
<td>• Collects children’s ideas for use in the planning process</td>
</tr>
<tr>
<td>• A place where pupils draw on previous knowledge</td>
</tr>
<tr>
<td>• Children should understand role of talk in learning process</td>
</tr>
<tr>
<td>• Helps me relate science learning to pupil’s prior experiences</td>
</tr>
<tr>
<td>• Enables pupils to become active agents of their own learning</td>
</tr>
<tr>
<td>• <strong>Gives choice and control to children; pupils can frame questions and make reasoned decisions</strong></td>
</tr>
</tbody>
</table>

Despite Emma’s experience, confidence and obvious passion for the ideals of peer group talk, there was still some sense of insecurity in the way she talked about her use of it in the final interview. Even though she mentioned her new ideas about pupils ‘being able to talk to each other about things and make their own decisions, come up with their own plans’ it was evident that she had feelings of tension; that learning through peer group talk was not a given it was still just a ‘possibility and chance that that’s going to happen’. She mentioned the idea of initially ‘going wild’ with group talk but that meant not getting ‘enough done, enough learning taking place’. Perhaps this is a reference to the need for some written work as proof of learning (Wallace and Louden, 2002, Alexander, 2008c) or it could be that there was an underlying insecurity.
about the learning potential of group talk activity which meant that beliefs about controlling dialogue surfaced. An overview of Emma’s beliefs, as explored in this section, is given in Table 5-2.

5.2.2. Arun

5.2.2.1. Initial espoused beliefs

During the interviews at the outset of the study, Arun demonstrated that he held beliefs about the importance of both having children actively participate in science and use talk to draw on each other as a learning resource; he also believed that children valued such opportunities:

*I think it is really important to have a practical lesson where the children are engaged with the topic...I give them the opportunity to talk in pairs for the questions I am asking and get them to work in groups for the practical part of it so hopefully they are talking and helping each other with understanding the science.*

_ARUN INITIAL INTERVIEW 1_

*I want them to be interactive, more engaged.*

_ARUN INITIAL INTERVIEW 2_

*I think that they do genuinely like talking to each other and finding out and feel as if there is someone else they can ask for help and not sitting there and feeling I can’t do this.*

_ARUN INITIAL INTERVIEW 1_

When asked about his feelings and approaches towards group talk in science Arun demonstrated beliefs about offering a sense of autonomy to children and mentioned a strategy of assigning roles within groups in order to develop a sense of ownership over their learning:

*You want them to be really creative and ask questions; allow them the freedom to ask questions.*

*It’s useful to give them roles within groups and they like that and they think yea I’m responsible for that and it makes them talk more cooperatively within the group.*

_ARUN INITIAL INTERVIEW 1_

These comments show that Arun had beliefs about the role of children having ownership and voice in the classroom through the sharing and discussing of ideas
(Rainer and Matthews, 2002), although a real sense of caution became evident from his use of language:

*I wouldn’t want a perfectly quiet classroom and I don’t mind generally them helping each other with problems in their work. So we very rarely have completely silent work in the classroom. We allow them to chat and ask each other questions where it’s appropriate and they are behaving sensibly and not taking advantage of that.*

Arun Initial Interview 1

And this tentative tone appears again when Arun is discussing his ideas about strategies for engaging pupils in talk (my underlining):

*So it is allowing them the space to generate their own ideas. You try and draw them into that their sort of contribution is vital... trying to allow them to have an opinion about something.*

Arun Initial Interview 2

Arun also made more explicit references to concern, focusing on behaviour issues which meant he felt uncomfortable about handing over responsibility to the children through group talk activity:

*So the only thing I worry about is behavioural problems among certain groups.*

*I think I would have the confidence if they did approach the tasks properly and did not go off and talk about irrelevant things. So that is always a worry where you’ve got children where the behaviour may be challenging where they fight and lose concentration but I’m generally willing to allow them to talk.*

*We just need to be careful who they are talking with because if they are too friendly they may be talking off task all the time.*

Arun Initial Interview 1

What the set of data extracts presented so far demonstrate is that Arun held constructivist beliefs about the importance of group talk for creating independent learners but that these are perhaps not secure. He believed that allowing children to talk and share their ideas was important however, the idea and practice of enacting this made him nervous and he also believed that often children don’t engage well in independent discussion tasks. There were clearly competing belief sets which inhibited him from enacting these fragile beliefs in practice (Fang, 1996, Wallace and Kang, 2004, Bryan, 2003) and the sense of his uncertainty was again highlighted when he adopted a hypothetical stance when talking about specific classroom peer group discussion strategies. He shared ideas about what the strategies could or should do
rather than what he had experienced they did, suggesting that there were inconsistencies between belief and practice:

... I think it would be a creative way for them to come up with the ideas, especially if they were involved with other children they would be able to magpie some of the ideas and learn about scientific principles... it allows them to investigate things for themselves and make them more independent, allowing them the space to be able to generate their own ideas and then investigate those ideas...they will be talking to each other about ideas of solving problems and they might also discuss with each other whether a certain thing would work or not, uhm, so they would be having a debate effectively if they were disagreeing about what path of the investigation to follow...they would also be exposed to things that maybe they hadn’t thought of before if they were working in groups. — Arun Initial Interview 2

In addition, towards the start of the project, Arun made repeated references to the peer group discussion approach he was trying as being new for him, novel for the children and how they needed to become more familiar with it. This evidence supports the conclusion that Arun’s initial beliefs in this area were fragile.

5.2.2.2. Beliefs in practice

During the observed lessons throughout the project Arun demonstrated his constructivist epistemological beliefs about learning through the provision of many peer group talk opportunities where children were encouraged to draw on, contribute and discuss their own prior knowledge. For example, he posed questions for the groups to consider; he used a range of sorting activities such as grouping objects based on their ideas about transparency; he asked children to discuss their understanding of particular scientific terms; he asked groups to create posters through thought showers and also used discussion resources such as Concept Cartoons. Often within lessons a parade of activities such as these were on offer leading the children through a series of ideas (Appendix 8.1 p.338 for lesson overview). After lessons Arun reflected upon his intentions for these sharing episodes, demonstrating his beliefs about talk being a useful medium for encouraging participation and enabling all children to both contribute and use one another as learning resources in the sharing and challenging of existing thinking:
I was trying to use a range of strategies to include as many people as possible...it was about trying to get them to think about their previous learning so that was useful...if they would have willingly contradicted each other and challenged each other that was what I was looking for.  

**Arun Oral Diary 1**

I was hoping that where children had come up with some misconceptions, the others would challenge them and talk about it.  

**Arun Oral Diary 2**

The intention was for children to highlight their own knowledge, then for other children to pick up ideas that they didn’t know themselves rather than me standing at the front and lecturing about it.  

**Arun Oral Diary 7**

In these oral diary extracts Arun also pointed to his desire for children to have a sense of power within the learning process, a responsibility for sharing and also for them to question each other, to look out for each other’s misconceptions and challenge them. In taking this perspective, Arun was perhaps attempting to position pupils as responsible for part of their learning however, after the first lessons when he reflected upon the groups’ sharing and questioning he said:

**Arun Oral Diary 1**

I did not see much of that going on...I need them to be more inquisitive and ask more questions.

**Arun Oral Diary 2**

If the group listening would have questioned them it might not have been a bad thing, it’s an aspect that I need to train the children on really to be more inquisitive and ask questions. They weren’t probing enough and that’s something they need to develop...they’ll need to work on those skills and we probably need to do a lesson where we’re saying what’s good sharing and be more explicit about those sorts of skills.

After these reflections and before each subsequent lesson, Arun acknowledged the active, social process of learning by reminding children about listening, taking turns to talk and asking questions of each other, invoking a set of ground rules he was apparently seeking to establish in order that pupils could have a structure for talking together without an adult to lead (Mercer, Wegerif and Dawes, 1999, Rojas-Drummond and Mercer, 2003) and for a number of lessons he also incorporated the strategy of giving roles to try and facilitate some level of ownership. At other times he provided written resources and prompts to facilitate independence in discussion activities such as vocabulary cards, question prompts or definitions of terms on the whiteboard. At times Arun made explicit mention to the groups how important the sharing of ideas was and also on a few occasions encouraged the children to reflect upon if and how talking with each other had enabled them to change their thinking; in
talking about talk he was demonstrating beliefs about children’s active role in the learning process (Mercer, Wegerif and Dawes, 1999). Arun emphasised with the children that their ideas were important, that they should not see themselves as wrong or right, that their ideas were ‘what you know now’, something to be worked on and in this way Arun tried to help children value their own thinking and activate it within the lessons. Throughout the project Arun almost always used the groups’ emerging ideas as starting points for whole class discussions and regularly used a strategy he called ‘envoying’. This involved one of the members of the group, after the initial discussion time, moving to a different group to share more widely their thoughts and collect new ideas from others which could then be reported back to the group. Through the use of pupil contributions and the provision of a wide range of opportunities to discuss ideas, Arun demonstrated that there were elements of consistency between his practice and his beliefs about pupil ownership through group talk. An emerging belief about children understanding the function of talk was apparent through Arun’s facilitation of metacognitive and reflective activity.

One of Arun’s concerns expressed at the end of the project was that he couldn’t be with all of the groups as they were talking and that there was potential to only hear snippets of dialogue:

*You don’t realise actually what sort of talk they do without being there constantly so when you are drifting in and out it doesn’t give you a true picture of the learning.*

*You were never aware of the sort of things that happen within discussions, because you cannot be with all the children at that time.*

Through these extracts it is possible to identify a tension for Arun between beliefs about giving ownership to pupils with his provision of spaces to talk so that they may make relevant and useful links for themselves, but also feeling that he needs to know what is going on in all of the groups, to have a handle on everything, to maintain a feeling of power over the workings of the classroom (Wallace and Louden, 2002). Arun seemed to have a number of strategies to reconcile this tension. In between opportunities for group talk, Arun facilitated whole class discussion over points raised between peers. He took each group in turn, and asked for a summary of the points
they had discussed and in this way perhaps he felt he was able to gain an understanding of what had been said in every corner of the room. He often treated each group’s summary to an evaluation or reformulation, perhaps adding more technical vocabulary at points before moving onto the next table in the room and by this practice seemed to stitch group talk episodes together with whole class discussions that were highly structured and authoritarian. He sometimes used what the children offered to make links between ideas and synthesised children’s thoughts into some sort of working consensus for the class, however at times, when Arun invited the groups to feedback into the main class, he stood scanning the room, almost on guard watching the rest of the class for disruption, not fully engaging with the group talking before inviting the next group to have their input. This demonstrated some level of anxiety over behaviour which apparently submerged other beliefs about the importance of working with the pupils’ emerging contributions.

Through the reflection on lesson nine Arun hinted at a role of the whole class discussion:

_I did the heavy handed bit of teaching before the independent bit because that’s the understanding I wanted them to gain but the other times really they had free rein and discussions. Yes I was conscious of the fact that they should get the chance to talk and then I take feedback, they get to talk, I take feedback and that was useful but keep my input in their groups minimal._

_ARUN ORAL DIARY 9_

The dynamic movement between whole class and small group opportunities has been highlighted as important in the literature as a way to provide scope for pupils to work with their own ideas, yet provide adult scaffolding (Mortimer and Scott, 2003, Mercer and Dawes, 2014, Michaels, O’Connor and Resnick, 2008). Arun seemed to use this strategy as a way to move between control and freedom, a way to balance the tension felt from the desire to allow the children space to discuss their ideas, yet keep them in line with the understandings he needed them to gain (Brodie, 2010, Orland-Barak, 2003, Wallace and Louden, 2002). His comment here suggests that he viewed the whole class forum as the workhorse, despite other beliefs about the central importance of peer group talk.
Another strategy Arun used to keep abreast of the progression of the group talk activity was a patrolling of the room whilst discussion was in progress alongside intervention within groups; his practice within both these dimensions altered over the course of the project. During some of the lessons, Arun moved between groups whilst they were talking, spending similar amounts of time with each one for what he referred to as further probing. During two of the early lessons he focussed his attention on a group which contained a child whom Arun thought to be disruptive and then on other occasions he began with a focus on one group and then patrolled around the others in no particular order. During lesson three Arun did something a little different; he spent time moving between groups but tended to intervene with encouragement to work collaboratively or give reasons and towards the end of the project Arun focussed his attention on only one group. What is interesting about this range of activity is that it seems that as Arun works with the peer group discussion approach he perhaps has uncertainty about his own role (Lefstein, 2010); he wants to provide opportunities for pupil ownership and give them freedom to develop ideas but also focusses on the importance of probing children’s understanding when they are in the groups. Indeed, early on in the study he talked about his mixed ideas about intervening:

...making a casual remark and then walking away can break their flow and thinking and so it’s how to actually encourage then to be independent and at the same time directing them in the way that the outcome is successful. It’s a very tricky balance to get so in a way you are thinking just get on with it but as a teacher you feel insecure in thinking you’ve not supported them enough.

Arun Oral Diary 2

Clearly, Arun feels a tension between his beliefs about ownership of group talk and beliefs about his role as a discourse guide for the scaffolding of learning. Two extracts from group discussions (See Transcription Box 5-5 and Transcription Box 5-6) exemplify the way in which Arun intervened in groups towards the start of the project.

The first extract comes from lesson one when the groups were working on electrical circuits. They had been asked to consider in their groups how they could make a bulb shine more brightly and plan for and carry out a test to check their ideas. The focus group had decided to change the amount of batteries in their circuit and was looking
at how this affected the bulb brightness when the teacher arrived in the group and asked what they had changed.

Transcription Box 5-5

Beth: batteries the amount of batteries
Oliver: and it lights up well bad
Lucy: four wires and some batteries
Oliver: we’ve only got a few extra wires
Teacher: have you kept the same wires why have you got extra wires you’ve changed the number of wires get rid of the extra wires all you are doing is adding batteries.
Oliver: but the only thing is it won’t work without adding more wires
Teacher: but you said you are keeping the wires the same
Nigel: no the light bulb
Teacher: what about the wires only change one thing at a time wires need to stay the same so take all those wires off and just use two otherwise it’s not a fair test.

At this point Arun proceeds to assist the group in rewiring their circuit and then moved off to another group.

ARUN PUPIL GROUP TALK LESSON 1

The second example comes from lesson two when the groups were discussing and recording on a large sheet of paper what they knew about light in a task designed to elicit pupils’ thinking at the start of a new topic. The group had begun to argue about whose turn it was next when the teacher arrived and reminded them of the task.

What these two extracts illustrate is the way in which Arun intervenes in groups with his questioning taking control of the ongoing dialogue. In the first example he finds that the group have not carried out a fair test and provides strict instructions to remedy this. In the second example we can see how he directs the course of discussion by first refocussing the group to the task and then by providing facts for the children to work with, prompting them to think in a particular direction. Finally before he moves off there is a sense that he is dismissing the emerging discussion on fire and light with his call to think of other facts. In a discussion that was designed for children to share what they know, where apparently nothing can be wrong, the types of
intervention selected by Arun seem to be at odds with his design and his espoused beliefs.

Transcription Box 5-6

Teacher: any more facts what about different places light comes from
Nigel: light comes from a bulb
Oliver: light can be erm
Lucy: I’ll just write light comes from bulb
Teacher: just write bulb
Nigel: lights need electricity to work
Teacher: does it always what about the sun
Nigel: no it has fire
Teacher: did you hear what Nigel just said
Nigel: sun is er the sun doesn’t need electricity
Oliver: what is the word for when nature makes like fire
Teacher: fire is a natural light you are saying
Oliver: the sun is a natural thing sun is natural light
Beth: how would you get a fire
Teacher: one person talking remember
Oliver: sun is natural light
Lucy & Nigel: sun is natural light
Lucy: you know if it’s a really if you are in a hot place and the sun is really hot if something erm gets hot like a or something it sets on fire
Oliver: light makes fire
Beth: I’ve got one
Oliver: ‘cos if you shine a lamp er you know
Beth: if you can’t sleep in the pitch dark you can use a nightlight
Oliver: you could say like set things on fire you could if you put a magnifying glass and shine a light on it it makes like the rays of fire
Teacher: okay what other facts do you know

With this final comment he moves off to work with another group.

Perhaps this range of strategies demonstrate some level of inconsistency between practice and espoused belief representing an attempt to keep control of the content and direction of children’s talk now that he was utilising group discussion with not as
much whole class discussion. An indicator of one basis for Arun’s discomfort came when he mentioned having the confidence to give children independence as one important consideration when planning using group discussion. Behaviour management appeared to be at the forefront of Arun’s mind during the study and even before any lessons were observed it was placed on the agenda; perhaps letting pupils go to talk was perhaps seen as a risk:

_Arun has already mentioned children’s behaviour a few times in the last few visits. He says he has concerns and that some of the children are challenging._

_RESEARCH JOURNAL 11TH SEPTEMBER 2012_

Before I would have been much more reluctant to allow the children to talk because I think well no, they’ll mess about or they’ll go off track or they’ll waste time...I’m less worried about that now.

_ARUN FINAL INTERVIEW 1_

I think I struggle with behaviour in class but I value the talk... now I have much more confidence in giving the children free rein to get on.

_ARUN FINAL INTERVIEW 1_

Arun also brought up developing questioning skills in children as a challenge he faced when using group talk work. He seemed to see it as something missing from the culture of his classroom and that perhaps it was down to his own insecurity in when and how to step into the discussion himself question:

_I wanted the groups to question more which they didn’t really do...It’s just that I want to develop the children into being more questioning of the children’s views, sometimes I feel a bit threatened, as if I haven’t got the confidence to actually say you’re wrong and have you thought about this type of thing, so it’s getting that culture really but yes, I intend to keep using those strategies._

_ARUN FINAL INTERVIEW 2_

Here Arun reveals that he has feelings of under confidence surrounding behaviour and trusting that the children will engage in relevant ways when left to work independently but also in his own ability to help pupils engage in high level features of talk. These beliefs about the dynamics of the classroom and his own skills have the potential to pull against his ideals of giving children ownership and independence (Pimentel and McNeill, 2013).

Through reading of the transcriptions of group discussion, however, Arun realised that children did in fact have wide ranging dialogue, were more often than not on task and
drew on many different ideas. As he read he saw the links pupils were making to their prior knowledge, links which were not obvious by listening to groups in passing and this enabled him to develop his appreciation for the importance of thinking about relevance of learning opportunities, a crucial dimension of facilitating ownership of learning (Enghag and Niedderer, 2008, Rainer and Matthews, 2002). In this way, the transcriptions became a reflective tool for Arun, enabling him to develop his ideas about the active nature of pupils’ thinking as revealed through their discourse. He reflected upon this function of the transcripts in the project and how he used them to understand how pupils were interacting:

*It does make you think actually, that your perceptions aren’t necessarily accurate. The dynamics of the children, the way they behave, the way they talk is different. It gives you confidence that they can generate their own ideas.*

ARUN FINAL INTERVIEW 1

...gives you an appreciation of actually yes, they do think about it, it might not be altogether or make sense to them, but they are thinking about it and actually personal experience is so valuable in them understanding it, so it’s shown me that to relate it to their own life experiences...we need to relate it to the age of these children, their experiences... ARUN ORAL DIARY 9

They give you an appreciation of actually yes they do think about it, it might not be altogether or make sense but they are thinking about it and actually personal experience is so valuable when they talk about science.

ARUN ORAL DIARY 9

... (you saw) the strange things, quirky things they might think up that actually and previously I would have slapped them down but having the transcript there gave a connection, there was some value to the point. Like when they started talking about potatoes one day when we were talking about plants. They’d remembered that a potato fuelled a speedway car and things like that make you realise they do have bits of knowledge and they need to connect it together.

ARUN FINAL INTERVIEW 1

Another note of interest was that Arun always carefully studied the transcripts of pupil talk and also the pupil interviews that were sent to him and each time he commented upon what he had picked up on from the previous sessions’ documents; for example when a child had suggested an interesting idea when working in their group, where he himself had asked an odd question or when pupils had made comments in interviews he felt he needed to respond to in order to develop classroom approaches. One
example of this was a strategy he put in place for turn taking which came about because he read some of the pupils saying that certain individuals dominated the group. The strategy wasn’t particularly successful but this does demonstrate Arun’s commitment to pupil voice and drawing on their ideas about the learning process, another feature of ownership (McIntyre, Pedder and Rudduck, 2005, Rainer and Matthews, 2002).

During some of the later oral dairies Arun explored his thoughts about the group discussion and his emerging view of it as space for children to get on with their own science talk, to contribute and work through their own ideas and to take some measure of control in how they directed their learning:

...so I gave them the independence to be able to do whatever they wanted to do....they had the chance to explore their own ideas... it was messy, but that was actually worthwhile that they did it themselves and learnt ... I basically gave them a free hand in planning the experiment. I was willing to actually let them get on with any experiment that they had devised.  

**Arun Oral Diary 6**

...let them get on with it and just have a free discussion, the questions were simple so everyone could engage in them and they had free rein to talk how they wanted within that...keep the questions focussed, stand back from the groups, allow them to discuss and they could take the discussion in whatever direction they wanted’ and that the talk was ‘for themselves really I wasn’t actually prompting them at all. I hardly went to any group really today and prompted them; all they did was support each other’s learning rather than me intervening...

**Arun Oral Diary 8**

...it was apparent today that Arun was leaving the children to their own devices a bit – he did not go around making comments about their work. He gave lots of opportunity to share, a sharing space for children it seemed. He suggested ideas about how he wanted them to work but let them go about their science by themselves with a structured regroup at points.

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At this point in the project, as has been previously mentioned, Arun did less patrolling of groups, focussing more time on one group within lessons but in addition his intervention strategies appear to have altered. The two next extracts exemplify this and show a contrasting picture to those presented earlier.

The first extract (See Transcription Box 5-7) occurred during lesson five. The group were discussing their ideas about the definitions of some properties of materials which
had been provided on word cards. Arun moved between groups throughout, listening to discussion and interjecting at points. Initially the focus group discussed and defined flexible quite easily but towards the end of the allocated time for discussion they struggled to define rigid.

**Transcription Box 5-7**

*Nigel: get on with rigid
Oliver: what the next one after flexible
Nigel: rigid rigid we've only got seventy more seconds rigid
Lucy: I think bendy
Oliver: for goodness sake
Lucy: rigid I have no idea what rigid means
Teacher: okay a word to describe this ruler what am I doing to it what word could describe how it is
Oliver: rigid that's rigid
Beth: flexible
Teacher: flexible okay and flexible is the opposite of rigid
Lucy: flexible means bendy
Teacher: so what does rigid mean
Lucy: straight
Beth: straight
Lucy: flexible is bendy
Oliver: is rigid like that (holding his hand out fixed) like this table*

The teacher leaves the group at this point.

*ARUN PUPIL GROUP TALK LESSON 5*

In the first extract (Transcription Box 5-7) we can see that Arun had listened and realised the group were in need of some direction. Although Arun guided the group in a quite structured way, the provision of an example to help them think about the property rather than the provision of a fact helped the children to consider for themselves new ideas based on their previous understanding. The second extract (See Transcription Box 5-8) occurred during lesson nine. The groups were discussing what they thought they ate food for in the context of a lesson on food groups. In this extract, although the intervention does not cause the group to move on to develop their ideas very much further, what is interesting is the nature of the interaction. Arun
simply requested the group to focus and followed this with a question to try and make them think more deeply about their ideas before he moved off. These two examples sit in contrast to the interventions towards the start of the study, presented earlier. They seem to provide support for the conclusion that Arun’s thinking about pupil ownership of group talk is developing, showing that his practice became more in line with his espoused beliefs as time passed.

Towards the latter stages of the project, Arun emphasised more explicitly with the children the importance of self-regulation and tied into his usual discussion on the purpose of group talk and review of ground rules a new emphasis on the importance of giving reasons and coming to decisions as a group. In aiming for pupil ownership,
Arun drew on his desire for children to use higher level talk features, perhaps hoping that this would enable children to develop their discussions and take an active role in working on their thinking (Chinn, O’Donnell and Jinks, 2000).

An anomalous point to note is that during the last few sessions where Arun spoke more strongly about giving pupils opportunities to be free to discuss in their own way, the amount of talk time devoted to groups was in fact reduced to short spells and whole class teaching dominated (Table 5-3).

<table>
<thead>
<tr>
<th>Lesson</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lesson time (mins)</td>
<td>60</td>
<td>65</td>
<td>90</td>
<td>100</td>
<td>65</td>
<td>90</td>
<td>80</td>
<td>70</td>
<td>60</td>
</tr>
<tr>
<td>Total group talk time (mins)</td>
<td>27</td>
<td>29</td>
<td>46</td>
<td>58</td>
<td>20</td>
<td>41</td>
<td>20</td>
<td>27</td>
<td>19.5</td>
</tr>
<tr>
<td>% of lesson for group talk</td>
<td>45</td>
<td>45</td>
<td>51</td>
<td>58</td>
<td>31</td>
<td>46</td>
<td>25</td>
<td>39</td>
<td>33</td>
</tr>
</tbody>
</table>

Data from pupil focus group interviews show that Arun’s pupils appear to have picked up some limited understandings of how they can take ownership in their discussion groups and use each other as a resource as these responses to interview questions about how talk helped them during the lesson show:

*Oliver: finding out other people’s ideas we get everyone’s ideas some people don’t think of something but other people think of it*

*Arun Pupil FG Interview 2*

*Lucy: other people give you ideas*

*Arun Pupil FG Interview 5*

*Nigel: when you talk in a group you get to share ideas*

*Arun Pupil FG Interview 7*

In one particular pupil interview Beth showed some despondency with her own outcomes for one of the talk tasks and her peers tried to encourage her, suggesting that they had an understanding of how they can use each other to develop their ideas:

*Beth: It was hard I didn’t get it that’s why*

*Oliver: you could have asked one of us*

*Nigel: you could have got people’s ideas the people on the table helped me*

*Arun Pupil FG Interview 4*
At times pupils showed glimmers of a wider appreciation of the space group talk gave them to follow their own ideas, be active in learning and consider possibilities:

*Oliver: talking about the cartoons at the beginning really helped me because it makes you think if it would work or not*  
*Arun Pupil FG Interview 1*

*Nigel: some people thought different answers like someone thought leaves make new flowers and someone thought sunflowers have seeds in the heads and make new flowers. We found different people’s opinions and now we are going to have a look with Mr X and see which one*  
*Arun Pupil FG Interview 8*

After a lesson where children were asked to work in groups to see what range of materials there was around school and then think about where these materials may have come from, the children talked about how talking had helped their learning and Lucy refers to appreciating being able to follow her own lines of thinking:

*Beth: it helped me to think about how you make rocks*

*Lucy: yea normally you wouldn’t just think mmm I wonder how rocks are made in the middle of a lesson but we could see the rock and wonder how it’s made*  
*Arun Pupil FG Interview 5*

What these extracts of pupils’ reflections show is that they have some understanding of the role of group talk in providing them with ownership over their learning but that this does not seem to have breadth. Pupils appear to value the opportunities they were given for talk and displayed a clear understanding of how they may use each other as a resource, indeed the notion of sharing ideas with each other came up during most pupil interviews but they perhaps do not have wider picture of how it may enable them to show autonomy (Pratt, 2006, Fisher and Larkin, 2008).

An insight into why this may be came when after lesson five Arun asked me to help him put tables back into their usual positions in readiness for the next lesson, which of course I did. I was curious however, because to this point in the project I had only seen the tables arranged in groups yet we were rearranging into rows. When I questioned Arun over this he told me that he only had the table arrangements for group talking when I was coming in due to behaviour issues; the science lessons it seemed were a special case and for all other activities different arrangements applied. This seems to demonstrate that although Arun talked about his beliefs regarding group talk and the
importance of letting children have the space and time to engage in it, in fact it seemed that for the majority of classroom time other beliefs about classroom organisation and pedagogy prevailed. This inconsistency may also begin to explain Arun’s concerns over how much time was required to establish a culture of talk in the classroom. He made comments about this, at the end of the project:

*It’s just developing that culture and that takes time...it takes a long time and it takes a lot of rehearsal and practice...with time and more practice the children will be more comfortable.*  

Arun Final Interview 1

Irregular routines for language use and interaction perhaps made it challenging for Arun to establish and maintain an authentic dialogic culture which comes into existence through social practices (Wertsch and Tulviste, 1998) and his practice perhaps provided mixed signals to pupils about how talk groups were valued. He did however during the final interview, make reference to allowing talk to ‘seep into other areas of the curriculum.’ These data suggest that Arun’s epistemological beliefs are mainly subject-specific. A further explanation for the pupils’ limited understanding of the utility of talk could stem from the authoritarian whole class discourse often employed by Arun. Modelling of effective dialogic interaction can have an impact upon children’s understanding and use of talk in their own independent groups (Gillies, 2013, Gillies, 2011).

At the close of the study, when talking about planning for group discussion Arun explored his beliefs about how using peers talking allowed him to hand over to the children, provide a sense of ownership. Compared to espoused beliefs from the start of the study they are much stronger in terms of the language used and sentiments displayed and Arun comes back to make his point on a number of occasions suggesting that it is of importance to him:

*The children take ownership much more of their own learning rather than being directed by the teacher all of the time. They are able to generate ideas themselves, discuss their ideas, address their misconceptions....so it’s the philosophy of it, let’s all work together, let’s generate ideas and let us all help each other learn...*

*I am just more likely to allow the children to have group talk where they have independence and have less direction from me.*
...give them a sense of independence... I would say let them have their head.

Actually, giving them the power, empowering them to actually lead the discussion.

So, less intervention from me, more input from the children...so it’s more child-led and less teacher-led.

...speak and generate their own ideas and discuss their own ideas, so trying to encourage a lot more independence in their thinking rather than directing them all the time about the way they think.

I’m more willing to give them time to talk and take it in whichever way they want. I don’t want to direct it so much as I used to want to do.

**Arun Final Interview 1**

It is clear from these extracts that Arun appreciated the power of group talk to foster in children a sense of independence and ownership in learning and that through the consideration of how to facilitate group discussion over the course of the project he appeared to have strengthened his ideals and espoused epistemological beliefs about this aspect of learning. His choice of language when referring to group talk suggests greater ease and more willingness to find ways to apply the strategy in the classroom than at the outset of the study. The transcripts of pupils talking in groups seemed to have provided a sense of what was actually happening which gave Arun confidence that his pupils could in fact talk together in sensible, coherent and productive ways which in turn perhaps had an impact upon his developing beliefs. However, what the data also demonstrate is that at times such beliefs were inconsistent with his practice and that significant tensions existed for Arun in the application of peer group talk in the classroom. The data suggest that Arun was moving towards a more pupil centred way of working, finding new strategies for intervening in groups when they were working. They also suggest that it was no easy or linear professional journey from directing learning to allowing for independence and ownership by using group discussions as a space for children to have their heads and work on understandings. An overview of Arun’s beliefs, as explored in this section, is given in Table 5-4.
Table 5-4: Overview of Arun’s beliefs about pupil ownership (bold items are those not elicited at the start of the study)

<table>
<thead>
<tr>
<th>Arun’s beliefs about group talk related to its potential for fostering active learners with ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer group talk:</td>
</tr>
<tr>
<td>• Encourages active participation</td>
</tr>
<tr>
<td>• Provides opportunities for pupils to discuss their own ideas</td>
</tr>
<tr>
<td>• Enables children to become resources for one another</td>
</tr>
<tr>
<td>• Provides spaces for everyone to contribute</td>
</tr>
<tr>
<td>• Gives responsibility to children for questioning each other</td>
</tr>
<tr>
<td>• Places where pupils contributions can be collected and used</td>
</tr>
<tr>
<td>• A place where pupils draw on previous knowledge</td>
</tr>
<tr>
<td>• Enables pupils to become active agents of their own learning</td>
</tr>
<tr>
<td>• Children should understand role of talk in learning process</td>
</tr>
</tbody>
</table>

5.2.3. Simon

5.2.3.1. Initial espoused beliefs

During the two interviews at the outset of the study Simon demonstrated that he held some beliefs about the importance of group discussion in relation to how it fosters ownership of learning in his pupils. Most of the extracts used to illustrate points in this section are short; therefore I have kept them within the main body of text and have identified the source with a (1) where the quote is from Simon Initial Interview 1 and (2) where the quote is from Simon Initial Interview 2.

Simon believed that group talk enabled children to become active and involved participants in their learning, that it helped to ‘make them engage in the thought processes’ (1) but also that it was a challenge to keep children focussed, involved and on task when they were working in such groups:

> The talking side of things I am happy to do, its maintaining the focus for all groups that I am not going to say I am 100% confident with.  
> Simon Initial Interview 1

Some comments about using group discussion strategies to generate thinking in science showed that he held loose beliefs about pupil ownership, that the provision of open ended, thought provoking questions meant that children could ‘just come up
with their own ideas’ (1). He mentioned more than once the importance of children expressing their own ideas about how they may go about tasks and giving reasons for them, referring to this as helping develop a ‘deep rooted level of engagement’ (2).

When discussing how talk was beneficial in science Simon referred to talking about completed activities and how that helped children in ‘taking hold of what they’ve done’ (1) and ‘sharing what they found, a bit of how they got there’ (2). It seems that Simon had beliefs about the potential of peer group talk to enable children to take ownership of a recent learning experience but he also referenced the difficulty of using it for children to think how they may take things further, although he acknowledged that group talk could have benefits for this. This perhaps suggests that Simon held beliefs about talk as being a useful vehicle for reviewing activity and reflecting on it, rather than it being a medium for pupils to work with what they currently know and lead from this, directing learning experiences in an autonomous way.

Simon espoused beliefs about the potential of group talk to be a space for everyone to contribute, saying that talking to peers provided pupils with ‘equal chances to share ideas’ (1) and that ‘group talk on any sort of level helps to erm to get a bit of parity’ (1). Highlighting his beliefs about the importance of creating spaces for everyone to contribute, he made particular reference to ‘the shy bairns at the back there saying nowt’ (2) and how group talk provided them with an opportunity to share and participate. He also felt children ‘value having their voice heard’ (1) and that providing opportunities for talk meant that children could ‘have more of a say to what they think is happening... it shows we are not just telling the kids everything, that they have a chance to contribute to a lesson’(2). Simon also held beliefs about the importance of children gaining metacognitive understandings about talking with peers; that they need to appreciate how they can learn from each other (Schraw, Crippen and Hartley, 2006). However, he also held doubts about how much the children in his class recognised this valuable dimension:

...(pupils) get a chance to share ideas whether or not they realise it I think they get a chance to learn more from not just listening to me but from listening to
what other children have to say but I don’t know if they necessarily recognise that.

Beliefs about how to foster group talk emerged through references to ground rules and protocols for children so that they were all involved and listening to one another:

Rules and protocols are you know observed in groups so that you know they are not all talking at once that there is an understanding of the importance of being able to talk and listen...in essence having firm established protocols and ground rules for group discussion.

These data from the initial interviews demonstrate that at the outset of the study Simon espoused beliefs about the role of peer group talk in science for helping foster pupil ownership of learning in his classroom, through the provision of spaces for children to contribute and discuss their ideas, through understanding that children are resources for one another’s learning and through an acknowledgement that pupils should be active participants in the learning process. However, these beliefs did not seem to be espoused strongly or in an extended way suggesting perhaps that they were peripheral (Luft and Roehrig, 2007). A constraining belief around pupil engagement also emerged but of particular note was an absence in the discussion about beliefs around relating to using pupils’ prior knowledge and the impact this may have on activating learning.

5.2.3.2. Beliefs in practice

Throughout all of the lessons of the project, Simon’s beliefs about having spaces for all pupils to contribute were enacted in part through his facilitation of whole class discussion, where he always drew on a wide range of pupils, provided lots of short paired talk opportunities and used the products of these interactions to drive his teacher led discussion forward. When a pupil made a contribution, Simon asked questions requiring further elaboration from them. He often linked different children’s ideas together and made explicit to the class how they connected. At times when a pupil made a suggestion, Simon offered it back to the class and asked them to work with a partner to discuss it. When he was synthesising ideas from the class, he took all contributions into account sometimes listing ideas on the board for all to consider. There were occasions where the children made contributions which were off track,
unexpected perhaps for Simon but he always gave the ideas space. What these observations perhaps suggest is that the whole class discussion forum was comfortable for Simon and he felt that it was an important area for demonstrating his belief about children contributing to classroom dialogue and having a voice in the learning process (Alexander, 2008c).

During the first lesson Simon demonstrated his beliefs about group talk being a useful forum for children to talk about an activity they were doing or had just done. The cross curricular learning topic at that time was earthquakes and the lesson centred on the children carrying out a fair test to investigate which material may be most effective at absorbing the impact of shaking on a house. After an initial whole class discussion on the importance of making buildings stronger in earthquake zones which was interspersed with short episodes of partner talk to collect ideas, Simon showed the children how to set up the resources for the test, which materials to use and how to change them; he told them to repeat their tests for reliability but to always build the same little house with the same amount of bricks. Simon demonstrated the testing procedure he wanted the children to use and asked the children to draw a conclusion from his result. He asked the groups to discuss for two minutes how they could and why they needed to keep some things the same in their test and following this the groups then began their testing activity. After the testing activity, groups were introduced to the recording worksheets and before writing up they were asked to review by talking with each other about what they had done, what they were trying to find out and how they had made it fair.

In this lesson, Simon used group discussion as a tool for carrying out a collaborative fair testing procedure and secondly to help children clarify thoughts; this latter function being a rehearsal for writing. Through his practice, Simon was enacting his beliefs about talk being useful for children to ‘take hold’ of an experience for themselves but there was no place given to the sharing of thinking which Simon espoused; no enactment of beliefs about using talk as a place for children to take ownership through a discussion of their own ideas. After the lesson Simon reflected on his intentions for the group talk:
discussions about what was kept the same and what was different, trying to hammer that home, the understanding of the fair test...I wanted them to come to the answer that I had set out really which they did which was great...the talking bit was to get them engaged with how it was set up so when they came to set up they weren’t following instructions, they had actually thought it through themselves so I tried to use talk for a bit of that...it was mixing it up still trying to give a bit of free rein but also trying to make sure there were limitations.

SIMON ORAL DIARY 1

It seems from this extract that Simon had experienced a tension; he wanted children to actively engage, use their own ideas, think the fair testing through for themselves and he had planned to use group talk as a forum for that but also he wanted children to follow his ways of thinking (Golding, 2013, Kim and Tan, 2011); Simon’s views about the learner’s active role became subservient to other beliefs (Anderson, 2015). The result was that although the children were free to carry out the test in groups, all the thinking had been done by the teacher and the children just had to follow his course.

The second lesson of the project was characterised by the ‘children working in groups but not working as a group’ phenomenon (Galton, Simon and Croll, 1980). The learning objective was for children to understand a food web and after a whole class discussion the children were sent to tables to work on individual paper based activities which required of them no discussion or interaction. The recorded children’s dialogue turned out to be a commentary on what they were doing as individuals. When reflecting on the lesson Simon brought this up himself:

"I wanted to continue with the talk groups how I’d been doing that and just to make sure they had the opportunity to talk...but I don’t think it kind of turned out that way. I think what ended up happening was that they were very much doing their own thing... I could go down a little bit further along the road with that, probably do more in the small group."

SIMON ORAL DIARY 2

In his reflection he talked not only about his own role in the ‘group work’ and how he had needed to move around the groups and lead the learning but also what was possibly missing, that there could have been more of a role for the children:

"I was just asking direct questions and getting them to resolve mistakes really, ask them the questions, closed questions but it was to get them to and so it was leading them... ...they didn’t really question what they had produced necessarily and again looking ahead maybe what that is that could be is a kind of peers being able to look at their work together."

SIMON ORAL DIARY 2
The data from this lesson show that Simon’s practice was inconsistent with his beliefs about the role of peer group talk in science for helping foster pupil ownership of learning and that in teaching this lesson; his beliefs about controlling the learning underpinned his decision making (Bryan, 2003). There was no explicit provision of a space for children to discuss together their ideas and the acknowledgement that pupils should be active in the learning process and use one another as a resource came after the lesson. This lesson’s data also serves to support the earlier conclusion that Simon’s beliefs about pupil ownership of learning through group talk are peripheral. What was also of interest was Simon’s reflection on his practice; almost creating a ‘note to self’ about how within the lesson he had been doing all the work and acknowledging the possibility of a different way of working, of providing a more active role for pupils within their group discussion.

A shift in emphasis was observed in the third lesson, where after a whole class discussion which at first collected together children’s ideas about light and then moved onto the nature of shadows, the groups were asked to talk about possible questions about shadows which they could investigate. Simon called this creating a research question and gave no further direction except to move between the groups, listening in to discussions, asking questions of them at points. After a short time he stopped the groups’ discussions to review their ideas as a whole class:

*All the children’s questions are commented upon; are children being given a confidence boost that their ideas are sound, that they can move forward with them? He leaves them to discuss their plans and quite naturally with no formal prompting the groups begin to work on their investigation.*

**SIMON LESSON OBSERVATION 3**

An extract from the recorded group discussion shows how the children used their own previous experience to begin to frame a question for their inquiry (see Transcription Box 5-9).

During this interchange, Simon valued the children’s ideas; he did not tell them what to investigate but his question did require them to think in more depth about their own ideas and he followed this with a reassuring comment and an invite to continue. Although he handed over ownership to the group in terms of allowing them autonomy
to frame their own questions and use their own ideas, his guidance was still an important feature in the group being able to successfully develop their inquiry focus.

Transcription Box 5-9

Tom: what could we do Andrew come on okay Andrew what could we think about
Andrew: I don’t know
Mark: size and shape
Tom: size and shape
Mark: I think size and shape
Tom: what could we investigate about size and shape and shadows
Ella: I’ve noticed have you noticed that when you walk down the street
Andrew: this is nothing to do with going down the street
Ella: and your shadow is really big
Tom: yea there’s a point
Ella: you know like a giant
Tom: if the light source
Andrew: yea they are really long
Tom: if the light source is bigger is our shadow bigger
Ella: yea
Tom: go on then do that

Simon approached the group at this point with a note of encouragement:

Teacher: okay that’s a good idea
Tom: cos when you are walking down the road because of the sun
Andrew: it looks really long
Tom: your shadow looks like you are a giant

The children talk a little more about their ideas and Simon asks an important question which helps the group to think a little more about their observations:

Teacher: so the sun doesn’t change so how does your shadow change
Tom: yea in the day it er it moves
Ella: yea
Teacher: alright so it doesn’t change it moves so okay then so what are you saying about your question then go on
Mark: if the light moves
Tom: what happens to the shadow if the light moves
Ella: yea

Simon Pupil Group Talk Lesson 3
The nature of Simon’s practice in this lesson was significantly different from the first inquiry lesson, described earlier where the thinking process was strictly controlled and structured for the children; they followed Simon’s ideas, not their own. In the oral diary after the lesson Simon referred to the group discussion as a ‘play around area’ and reflected upon his plans for using talk on this particular occasion and also how he felt the children benefitted:

*I wanted the group talk at the tables so they could decide what they wanted to do and they could build on that and come to a decision, so it’s you come up with this question, now how are you going to carry it out...well it’s about self-learning and taking ownership of their learning, because if I’m just spoon-feeding them I’m not really doing my job so it’s a balancing act that one...you come up with this question how you’re going to carry it out, so the idea was to have, to decide as a group what they were talking about and to think about the type of questions really.*

*Simon Oral Diary 3*

...to come up with their own ideas and see it through...things (ideas) don’t have to be given from one place...they experienced talking in the group and they experienced the fact that they learned through that...that they can come with something, their own ideas and test to see if those ideas work.

*Simon Oral Diary 3*

The comments and the structuring of the group discussion activity demonstrate a shift in thinking for Simon. They show that he is drawing more strongly on his beliefs that children should appreciate that they have an active role in the learning process; that not everything needs to come from the teacher and they can explore and draw on one another’s ideas to develop their thinking. Through the data from this lesson Simon demonstrated greater consistency between his espoused beliefs and his practice. In order to develop pupils’ understanding of shadows, he appears to have considered using peer group talk as a vehicle to encourage children to be resources for one another, to explore ideas, to show autonomy and frame their own questions, to make decisions and direct the course of their learning (Enghag and Niedderer, 2008, Rainer and Matthews, 2002); his practice demonstrated a more constructivist stance.

This theme is continued into the next lesson based around the concept of refraction where the children were asked to work in groups and share their ideas about how to ‘bend a pencil’.
That’s what I wanted it to be today...they had to just go right, this is a challenge but we know it’s doable...and they were challenging and that was great...they were engaged in what they were doing, they were thinking about what was going on...the fact that they were involved in the process of getting there, I think that really helped strengthen the learning.

SIMON ORAL DIARY 4

During this lesson Simon also provided an activity where the children had a number of Talking Points (Dawes, 2012) about light to discuss and during the final lesson Simon asked the groups to share their thoughts about a range of ideas about possible ways to become a more ‘green’ school. Groups were asked to make decisions about which ones were most important and why. After the lesson he reflected upon his ideas about the activity:

*If I was giving them the information, teaching them the knowledge, the safe home teaching, then I don’t think they would have necessarily retained it, going through that way seemed better.*

SIMON ORAL DIARY 4

By including more opportunities for children to have a voice and explore their own ideas through open ended activity and shifting from ‘safe’ teacher led activity, Simon seemed to be shifting his practice to be more in line with his initially espoused belief of using talk to achieve deep rooted engagement in learning but what was interesting to note was that as the project progressed the time for children to talk in lessons declined (Table 5-5 below).

Table 5-5: Table of talk time in Simon’s lessons

<table>
<thead>
<tr>
<th>Lesson</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total lesson time (mins)</td>
<td>63</td>
<td>48</td>
<td>72</td>
<td>83</td>
<td>56</td>
</tr>
<tr>
<td>Total group talk time (mins)</td>
<td>28</td>
<td>21.5</td>
<td>28.5</td>
<td>32.5</td>
<td>11</td>
</tr>
<tr>
<td>% of lesson for group talk</td>
<td>44</td>
<td>45</td>
<td>40</td>
<td>39</td>
<td>20</td>
</tr>
</tbody>
</table>

During the plenary of lesson four, Simon focussed on a reflection of how the group talk task had helped pupils to develop their ideas; how it felt to have access to other people’s thinking. With this practice, Simon seemed to draw on his initial espoused beliefs about children developing a metacognitive understanding of the process of group talk so that they may begin to become more self-regulating (Schraw, Crippen and Hartley, 2006). The children made brief references in some of the later interviews.
to ideas about taking ownership through the use of their own ideas and others as a resource but their ideas were not extended showing their understanding was not well developed (Fisher and Larkin, 2008):

Tom: we all helped each other we shared our ideas and put them together to make it really good

Mark: we all got involved

Ella: we are doing our idea I like it when we share ideas

Tom: we all had our own ideas

Ella: we all got see the ideas so it was kind of like we learned things from other people

Tom: people had parts of ideas but not fully

Ella: so we added them together we all agreed

During the final interviews Simon took a number of opportunities to speak about his use of group talk and how this related to pupils having ownership of their own learning. He now explicitly referred to using pupils’ own ideas and how group discussion could be a forum for moving forwards not just looking back. A shift in this area of his practice had been observed, as described in this section but the fact that Simon had drawn this into his espoused belief set is also significant and is an indicator of changes in thinking. The extended way in which he spoke about his ideas about ownership is perhaps support for a conclusion that other beliefs in this area had strengthened:

It’s challenged me to make sure I’m not just doing talk partners and made me think about again where is it useful and how it can be generated without me being involved all the time and again that comes in terms of allowing more trust with the groups and they are actually going to come up with an outcome, that they are not just chatting.

Allow them discussion time to come up with an idea... prior understanding, allowing that option to explore their own ideas.

They’re taking ownership of it which they really can’t do on the carpet they can’t take that ownership, they respond and they can understand but they can’t go right this I what I understand where does it go from here? I think that is what you can get from group discussion.
It’s not teacher-led all the time there’s going to be teacher involvement because I think stepping in there just to make sure they are on track and sometimes deliver a few key questions but them leave them to it, just over see it they get a lot from that knowing it was their work.

Simon Final Interview 1

...give them a little bit more independence, so when it comes to finding out, it’s to make sure that I don’t sometimes tell them...and it sort of makes them think about that sort of process, otherwise I think they’re on that conveyor belt expecting to have things handed to them and they’re going through the motions rather than actually being part of the process, so I think that’s pretty strong...it’s only when they start doing things themselves, which has been really interesting, you start thinking actually there’s potential there for them to go forward with their learning a lot more away from just me asking the questions and so what I’ve taken from that is trying to give them that little bit more trust, a little bit more independence but equally knowing I still need to have an outcome.

Simon Final Interview 2

At this point Simon also voiced concerns about using group talk to allow pupils to have ownership because it was challenging to ‘grasp the full extent of what they’ve done’ Simon Final Interview 2 and bring the content together. Simon also hinted in the interview that he found developing opportunities for productive talk a challenging task, that it involved thinking creatively and working in different ways to those with which he was used. Simon admitted that he generally only used group discussion strategies when there was an observed lesson but was conscious that this:

...might sound like the wrong motivation but it’s not, because it forced me to think differently so with you coming in I thought well I need to make sure that it is different. I don’t feel that it has been a chain around my ankle but you are put on the spot you think how can I do this...

Simon Final Interview 1

He suggested that he had tried out using group talk in other areas of the curriculum but that sometimes it had not worked well for him. These comments perhaps demonstrate Simon’s uncertainties about drawing on group talk and also indicate that despite strengthening his beliefs around using group talk they were still not firmly held and that other beliefs dominated which may have hindered the implementation of this pedagogy in his classroom (Bryan, 2003, King, Shumow and Lietz, 2001, Pajares, 1992, Wallace and Priestley, 2011). An overview of Simon’s beliefs, as explored in this section, is given in Table 5-6.
Table 5-6: Overview of Simon’s beliefs about pupil ownership (items in bold are those not elicited at the start of the study)

<table>
<thead>
<tr>
<th>Simon’s beliefs about group talk related to its potential for fostering active learners with ownership</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peer group talk:</td>
</tr>
<tr>
<td>• Encourages active participation</td>
</tr>
<tr>
<td>• Provides opportunities for pupils to discuss their own ideas about carrying out tasks</td>
</tr>
<tr>
<td>• Enables children to become resources for one another</td>
</tr>
<tr>
<td>• Provides spaces for everyone to contribute</td>
</tr>
<tr>
<td>• Children should understand role of talk in learning process</td>
</tr>
<tr>
<td>• Provides opportunities for children to rehearse for writing</td>
</tr>
<tr>
<td>• Enables pupils to become active agents of their own learning</td>
</tr>
<tr>
<td>• A place where pupils can draw on previous knowledge</td>
</tr>
<tr>
<td>• Gives some control to children; pupils can frame questions and make reasoned decisions</td>
</tr>
</tbody>
</table>

5.2.4. Discussion

The presentation of the data analysis demonstrates how over time, as teachers considered more deeply their use of group discussion techniques, there was a greater emphasis on pupil autonomy of learning and in the classroom they began to hand some measure of ownership to their pupils. Ownership of learning is an important concept and an integral part of the constructivist perspective to learning which places emphasis on the active role of the child (Driver, Guesne and Tiberghein, 1985, Fensham, Gunstone and White, 1994, Scott, 1987, Driver, 1989, Duit and Treagust, 2003, Vygotsky, 1986). Constructivism regards the learner as intimately connected to the process of learning, engaging with classroom activity and exposing their personal frames of thinking to a close encounter with new ideas presented to them. The onus is placed upon learners to be active not passive classroom participants and in this way they theoretically have ownership of the sense making process which will enable them to develop conceptual understanding. Taking a constructivist stance through classroom practice can be thought of as activating epistemological beliefs about the role of pupils in the process of learning (Hashweh, 1996) and using dialogic approaches involves assuming an epistemological position (Lefstein, 2010). The teachers in this study demonstrated constructivist epistemological beliefs (Table 5-7) about the role of group discussion in fostering pupil ownership of learning but classroom observations
Table 5-7: Overview of elicited teacher beliefs about pupil ownership (Bold items are those not elicited at the start of the study). Note: It can be expected that each teacher may hold further beliefs in their system of thinking about pupil ownership but listed here those which were elicited through the course of the study.

| Teacher beliefs about group talk related to its potential for fostering active learners with ownership |
|---------------------------------------------------------------|---------------------------------------------------------------|---------------------------------------------------------------|
| **Emma** | **Arun** | **Simon** |
| Peer group talk: | Peer group talk: | Peer group talk: |
| - Encourages active participation | - Encourages active participation | - Encourages active participation |
| - Provides opportunities for pupils to discuss their own ideas | - Provides opportunities for pupils to discuss their own ideas | - Provides opportunities for pupils to discuss their own ideas |
| - Enables children to become resources for one another | - Enables children to become resources for one another | - Enables children to become resources for one another |
| - Provides spaces for everyone to contribute | - Provides spaces for everyone to contribute | - Provides spaces for everyone to contribute |
| - Gives responsibility to children for questioning each other | - Gives responsibility to children for questioning each other | - Children should understand role of talk in learning process |
| - Collects children’s ideas for use in the planning process | - Places where pupils contributions can be collected and used | - Provides opportunities for children to rehearse for writing |
| - A place where pupils draw on previous knowledge | - A place where pupils draw on previous knowledge | - Enables pupils to become active agents of their own learning |
| - Children should understand role of talk in learning process | - Enables pupils to become active agents of their own learning | - Children should understand role of talk in learning process |
| - Helps me relate science learning to pupil’s prior experiences | - Children should understand role of talk in learning process | - A place where pupils can draw on previous knowledge |
| - Enables pupils to become active agents of their own learning | - Gives some control to children; pupils can frame questions and make reasoned decisions | |
| - **Gives choice and control to children; pupils can frame questions and make reasoned decisions** | | |
and teacher reflections showed that in practice there were tensions from other belief sets which constrained the enactment of such beliefs (Prawat, 1992, Wallace and Louden, 2002, Wallace and Kang, 2004, Bryan, 2003) and therefore inconsistency between belief and practice was evident (Mansour, 2013).

Over the course of the project as Emma, Simon and Arun used and reflected upon peer group discussion strategies and their impact upon pupils, epistemological beliefs around pupil ownership were strengthened and a small number of new ones developed, resulting in a move towards more constructivist approaches in the classroom (Richardson, 1996) and a greater congruence between their espoused beliefs and their practice (Waters-Adams, 2006). This demonstrates that the belief systems of these teachers did develop as both reflection on experience and reflection on pupils’ responses exerted their influence, although this change occurred slowly (Bryan, 2003). The change was noted through classroom observation and through the teachers’ own ongoing and final reflections upon their practice.

Guskey’s model of teacher change (2002) proposes that a defining factor in belief change is the observation of positive pupil learning outcomes. This effect is visible in this study, through Arun’s deliberate and careful consideration of the transcripts which provided him with evidence that his pupils did in fact use talk purposefully when they were placed in peer groups. In this way the project data became a reflective tool for Arun, causing him to challenge previously held assumptions about the learners in his classroom (Calderhead, 1993), consolidate his understanding of the teaching and learning process and reconsider his own role within it. However, what also occurred with Emma was that reflection on pupil’s negative responses to their learning experiences as elicited through the focus group interviews had an influence on the way in which she drew on her belief set, resulting in greater consistency between espoused belief and practice. Feelings of disquiet (Dewey, 1909), made explicit during the oral diary reflection and cemented by the aforementioned pupil responses caused Emma to develop a greater consciousness about an aspect of practice, approach subsequent teaching experiences in a manner mediated by reflection (Jones and Connolly, 2001) and construct new understandings about the role of the teacher and the learner (Bolton, 2001).
Emma felt that the central prompt for reflection was the children’s responses:

*I’m a lot more aware of it (group talk) and how useful it is, in the fact that mainly from the conversations that the children have had afterwards and the transcripts, so it’s changed my teaching in that way.*

**EMMA FINAL INTERVIEW 1**

Reflection upon practice but also on the effects of that practice upon pupils influenced Emma and through her use of and response to the data collected for the study, she worked as teacher researcher (Stenhouse, 1975, Day, 2000); she challenged the constraints upon her own action, experimented with new ways of working and constructed new personal, professional thinking.

Arun’s oral diary reflections on the importance of helping children to develop metacognitive understandings about talk also had implications for future action (Scaife, 2010). Making external and explicit his hopes for the way in which his peer groups would interact, perhaps went some way to help him develop a more conscious awareness of his own beliefs and make the move to experiment with a range of ways through which he could facilitate greater pupil ownership in the classroom.

For Simon the process of reflection after the second lesson seems to have begun the shift towards a greater consistency between belief and practice. Through his brief analysis, Simon queried and problematised his practice (Bolton, 2001) and this externalisation of thoughts and concerns about his role in the lesson apparently created implications for future action (Scaife, 2010, Bruner, 1996) and led to the incorporation of constructivist ideas about pupils drawing on their own prior knowledge into his belief set. In addition, for Simon the perceived pressure of observation apparently caused him to consider more deeply the kind of practice he wanted to see occurring in this classroom. His mention of feeling ‘forced to think’ is perhaps an indication that focussed reflection around peer group talk may not have occurred spontaneously and that the reflective conversation was a catalyst for the evolution of new insights (Goodfellow, 2000) and even for belief shift (Vaino, Holbrook and Rannikmae, 2013).

The oral diary became a space where unsettling concerns were unearthed through the deconstruction of practice, a place where uncertainty was recognised and
acknowledged. They were a powerful tool for providing a window into teachers’ changing ways of thinking and they provided evidence of a teacher building tentative bridges to new professional knowledge and classroom practices (Bolton, 2001). In addition, listening to and taking account of more than one perspective prompted some reconstruction of reality with new ways forward emerging for participants (Schön, 1987). The process of belief strengthening that became visible through the analysis across the three settings serves to highlight the interdependence between belief and practice which was noted in the literature (Wallace and Priestley, 2011).

What emerges from the analysis is the central importance of ideas about the role pupils are enabled to take in the process of learning through peer group discussion. In practice, handing over ownership does not mean that teachers abandon their pupils; crucially teachers have a mediating role to play (Vygotsky, 1986) but handing over ownership does involve the teacher in an acknowledgement of the active role of the learner in constructing their own understandings and the provision of opportunities where they are able to do this. The teachers in this study all moved towards their constructivist espoused beliefs about the active role of pupils in learning by adapting their practice:

- Planning for more opportunities for pupils to engage with each other’s ideas and draw on their previous conceptual understanding
- Providing pupils with opportunities to follow their own lines of thinking, frame their own questions and make their own reasoned decisions
- Ensuring pupils have a common understanding from which to work when they are without the teacher
- Intervening in group discussions in ways which do not take over the discourse but require pupils to consider more deeply their own lines of thinking
- Engaging pupils in reflection upon the potential of talk in the learning process

Although the pupils did not generally have extended or well developed explicit beliefs about how talk specifically enabled learning, there was evidence of some evolution in thinking about the learning process and their role within it. The pupils demonstrated an eagerness for ownership and responsibility in the classroom, ideas which became
visible through the transcripts and this stimulated and strengthened the development of teacher thinking about peer group discussion. In this way the pupil perspectives became a powerful force, shaping the dialogic opportunities made available in the classroom and therefore perhaps the study did in fact act as an intervention due to the dynamic use of the data by participants, although this was not the intention as has been previously discussed in Chapter 3.

Changes in teacher thinking will be considered again in the next chapter, with the focus on ideas about peer group talk and scientific inquiry.
6. Changes in Teacher Thinking: Scientific Inquiry
6.1. Introduction

Inquiry based science can provide an effective impetus for the exploration of ideas by learners through their interaction with others (Haneda and Wells, 2010). Through a consideration of the use of peer group discussion, all three teachers used scientific inquiry as an opportunity for facilitating talk, demonstrating beliefs about inquiry based learning as an effective backdrop for dialogic activity. The literature review enabled me to draw together a framework for looking at the inquiry opportunities which were provided to the peer groups and within which they were expected to engage in dialogue. Figure 6-1 details dimensions of inquiry elicited from the literature (Alake-Tuenter et al, 2012, Chinn and Malhotra, 2002, Harlen, 2013).

Figure 6-1: Dimensions of inquiry

<table>
<thead>
<tr>
<th>Dimensions of Inquiry</th>
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</thead>
<tbody>
<tr>
<td>• Asking questions</td>
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<tr>
<td>• Making predictions</td>
</tr>
<tr>
<td>• Planning and carrying out investigations</td>
</tr>
<tr>
<td>• Gathering data</td>
</tr>
<tr>
<td>• Discussing results and interpreting data</td>
</tr>
<tr>
<td>• Drawing reasoned conclusions</td>
</tr>
<tr>
<td>• Making explanations and communicating findings</td>
</tr>
<tr>
<td>• Evaluating inquiry process and finding flaws</td>
</tr>
<tr>
<td>• Making links to other inquiries</td>
</tr>
</tbody>
</table>

The table provided useful theoretical guidance for the deductive analysis of data for this change theme. The following sections show how each teacher demonstrated epistemological beliefs about science learning in relation to the use of inquiry for facilitating peer group discussion and also how these shifted over time. Beliefs which are discussed were both espoused and more tacit the latter being identified through observation of practice (Wallace and Kang, 2004, Wallace and Priestley, 2011). The presentation of data which follows this introduction should be seen as a story running parallel to that offered in the previous chapter and so I again begin with initial beliefs of participating teachers.
6.2. Initial espoused beliefs

During the interviews at the start of the project, the teachers discussed how peer group talk supported their approach to science teaching, focussing on using talk for collaborative planning of practical and inquiry work and also for sharing ideas. The responses provided a window on beliefs held about science and the process of science teaching and learning and there appeared to be two themes with this initial thinking about talk and scientific inquiry, as illustrated in the following sections.

6.2.1. Inquiry talk

During this initial phase of the project, Emma rarely mentioned ideas about science being a process of inquiry in fact she stated ‘I think science is very knowledge based’

*Emma Initial Interview 1.* However, she did mention that science is practical and that group discussion enables children to plan experiments and investigations:

> They talk about the equipment they want to use if it’s an investigation or something like that ...they work as a group and come up with their own way of doing an experiment because that way they can make their own mistakes.

*Emma Initial Interview 1*

> ...when we are planning investigations they have to talk it through.

*Emma Initial Interview 2*

Emma also made reference to the fact that she provided opportunities for group talk during practical work in order to help children understand new concepts, referring to it as a way of ‘developing their how to get to those facts’ and she mentioned ‘the thinking side and then the practical side and the process’ of science *Emma Initial Interview 2.* These comments perhaps indicate that within Emma’s belief system there are ideas about science being a process of collaboration and cooperation (Osborne et al, 2003) and that a characteristic of science is that empirical work is linked to knowing (Bartos and Lederman, 2014).

Arun espoused beliefs about the importance of inquiry type activity for science learning and how this provides a setting for group discussion:

> I get them to work in groups for the practical part of it so hopefully they are talking and helping each other... I want all the children to be really
experimenting and have the opportunity to learn in that way.

Arun Initial Interview 1

Planning an investigation encourages them to think without there being a strict way of just filling in a work sheet... it’s the whole process of investigative skills you are developing in them. Arun Initial Interview 2

These comments show that Arun held beliefs about the place of peer group discussion for planning an investigation and carrying out practical work and he relates this to his desire to develop inquiry skills with his pupils, demonstrating beliefs about the value of inquiry based approaches to learning and also science as a process.

At the beginning of the study Simon also expressed his beliefs about the importance of investigation in science learning:

...one thing that is important is trying to get science investigation, having a question. I always try and lead it off with a question certainly...every investigation starts with asking a question. Actually that is what is different to maths, with maths you are trying to find the facts but with science is actually trying to investigate further a question or statement being able to prove whether something is right or wrong. Simon Initial Interview 1

Although this extract demonstrates that Simon held ideas about science as a process of inquiry, he perhaps viewed investigation in the classroom in a limited way; as a tool to help confirm a body of knowledge with pupils (Banchi and Bell, 2008). During the card sort interview where Simon was able to talk in a more free way about his use of talk in science there was no reference to inquiry which perhaps suggests that this area of science learning is not a priority when thinking about children in dialogue with one another.

6.2.2. Sharing ideas and words for developing understanding

At the outset of the study, Emma espoused beliefs about the potential of peer group talk for developing children’s scientific knowledge and understanding. There was a strong current of dialogue referring to children learning science through an exchange of ideas and experiences - explaining them, considering the range of perspectives and positively challenging and questioning each other in order to construct new understandings (Barnes, 2008):
Group work is for them to challenge each other... it is about listening to each other and how they can add to things and change things ...they will come up with not just one idea but what all the ideas could be and then choose from there...they can all come up with ideas and then they explain their ideas, they have to take their ideas to somebody else and explain that and then they can challenge it or agree it or come up again with an even better idea or something.

**EMMA INITIAL INTERVIEW 1**

By sharing what everyone thinks they can pick up on different ways that other children see things... it allows you to agree or disagree with each other and then maybe be challenged or maybe – ‘oh I didn’t think of that.

**EMMA INITIAL INTERVIEW 2**

She also referred to the importance of children using group talk for building connections in their scientific knowledge structures to see ‘the links to other things, so they are not just learning the one thing there and one thing there and not making those links but being able to build on them’; she refers to this as a ‘work in progress, a building thing’ **EMMA INITIAL INTERVIEW 1**. By sharing her thoughts about the purpose of group talk in science in these ways, Emma revealed beliefs both about the nature of science as a body of knowledge to be understood, a set of interconnecting ideas to be constructed by pupils and about the potential of discussion tasks for facilitating this.

At the beginning of the study Arun espoused beliefs about the use of group talk for science learning and the potential it held for helping children develop their factual knowledge through the exchange or consolidation of ideas:

*The talking is more to reinforce knowledge I think and maybe plug gaps where some children might not have the knowledge, so talking in pairs would mean they would find out from each other... uhm and it is a sharing of information as well. Uhm it just makes it more interactive, rather than teacher led talking to them.*

**ARUN INITIAL INTERVIEW 2**

This data extract could be interpreted in terms of Arun’s beliefs about the nature of science learning being the collection of knowledge by pupils and that discussion tasks can facilitate this process as children exchange ideas with one another. Other initial interview data support this and demonstrate that Arun held beliefs about the importance of children talking in groups to practice and consolidate their use of scientific vocabulary:
Vocabulary practice helps to re-emphasise what the correct vocabulary is, probably reinforcing the knowledge within groups...obviously you have to get them to use the correct vocabulary all the time, I would try and do that throughout all lessons...it’s part of their speaking and listening I want to develop as well and get them to extend their vocabulary and use the correct vocabulary in the correct situation.  

**Arun Initial Interview 2**

What these data demonstrate is that Arun held beliefs about science being a body of knowledge to learn and that group talk enables children to become familiar and confident with the technical vocabulary of the subject.

Simon also discussed the role of talk in science learning for the consolidation of conceptual understanding and development of vocabulary use:

*It’s about clarity and understanding of the subject they are talking about, vocabulary, erm, concepts, understanding of what they are trying to investigate all that sort of thing...trying to share a good range of vocabulary and build on the vocabulary.*  

**Simon Initial Interview 1**

You want to give the children time to practice their vocabulary that’s going to be technical to that particular science topic so you give an opportunity to use that in a context and you can use talk to get them to verbalise it instead of writing it down. I think that is important. To understand what it means. I think they would not use it if they don’t know what it means. So you are encouraging them to use it and also forcing it upon them. You might have a word bank to encourage them to use those words or to incentivise them to use those types of words...making sure that children of all abilities have access to a wide range of words they can use if they want to.  

**Simon Initial Interview 2**

What the data from these early interviews reveal is that Simon seemed to hold epistemological beliefs about science being a body of knowledge to be understood and referred to in specific ways; beliefs which lead him to emphasise children expressing their knowledge with clarity and precision and therefore he perhaps sees the role of talk for more presentational purposes (Barnes, 1992) rather than as a tool for working on understandings.

Table 6-1 provides an overview of the initial epistemological beliefs of the three teachers, as described in this section.
Table 6-1: Overview of initial epistemological beliefs

<table>
<thead>
<tr>
<th></th>
<th>Emma</th>
<th>Arun</th>
<th>Simon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>About science</strong></td>
<td>Science is practical</td>
<td>Science is a process of inquiry</td>
<td>Inquiry confirms knowledge</td>
</tr>
<tr>
<td></td>
<td>Practical work is linked to knowing</td>
<td>Scientific understanding achieved through inquiry</td>
<td>Science is a body of knowledge</td>
</tr>
<tr>
<td></td>
<td>Science is collaborative</td>
<td>Inquiry confirms knowledge</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Science is a body of knowledge</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>About science learning and how peer group talk facilitates this</strong></td>
<td>Group talk for planning and conducting practical work</td>
<td>Group talk for planning and conducting practical work</td>
<td>Group talk for presenting scientific knowledge</td>
</tr>
<tr>
<td></td>
<td>Group talk for developing scientific knowledge through an exchange of ideas and experiences</td>
<td>Group talk for developing scientific knowledge through an exchange of ideas and experiences</td>
<td></td>
</tr>
</tbody>
</table>

6.3. Beliefs in practice

Throughout the project the teachers demonstrated beliefs about science teaching and learning through their application of peer group talk within their lessons and through their oral diary reflections. What became visible was a shift towards thinking about using talk for authentic inquiry activity rather than simply for collaborative practical work although at times this development created tension. Classroom practice and oral diary entries again provided a window on beliefs held about science and the process of science teaching and learning and I have considered these around three themes: science talk for collaborative activity, science talk for vocabulary and science talk for authentic inquiry.
6.3.1. Science talk for collaborative activity

6.3.1.1. Emma

During the first two observed lessons of the study Emma demonstrated her espoused beliefs about the benefits of engaging children in an exchange of ideas in order to develop their understanding. Children were asked in the first lesson to discuss their ideas about feeding relationships and the impact on organisms when changes to an environment occurred; in lesson two children were asked to share their ideas about the human skeleton. During both lessons, Emma intermittently encouraged the children to share what they know and commented to the class during the first lesson that ‘science is about sharing ideas’ EMMA LESSON OBSERVATION 1. Afterwards she reflected about the aim for and outcomes of the peer group talk:

I wanted them to talk in a group so they could share their ideas and sort of agree something ‘cos even in the lesson some were saying no that’s not right they felt brave enough to challenge and just say and I like that so I wanted that in the group activity to take place so they could all talk about it and no one has to really worry about writing...being able to put their ideas forward and then others trying to challenge them and come up with reasons, make them think of reasons for their thinking... I think that those that were involved learned something new or added to what they knew by either telling it to someone else or finding it out from someone else in the group so I think that it moved them on. EMMA ORAL DIARY 1

Pupils were clear that sharing ideas was useful:

Sam: when we talked in the group everyone shared their ideas and then we all understood

Ali: we were all in a group and all helping each other EMMA PUPIL FG INTERVIEW 1

During the third and fourth lessons Emma drew on her espoused beliefs about science being a collaborative and practical process, on both occasions the focus of the group talk being a sharing of ideas in order to plan an investigation which could answer a given question:

...children are told to listen to everyone’s ideas. Emma says to take turns to share ideas and take them all and make a group idea from them. EMMA LESSON OBSERVATION 3
Indeed the focus on using group talk for planning and carrying out collaborative inquiry continued throughout the project as can be seen from Table 6-2.

**Table 6-2: Inquiry focus in Emma’s lessons**

<table>
<thead>
<tr>
<th>Emma Lesson</th>
<th>Inquiry skill required for group talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Making predictions about a scenario</td>
</tr>
<tr>
<td>2</td>
<td>No inquiry activity in lesson</td>
</tr>
<tr>
<td>3</td>
<td>Plan inquiry procedure; Consider the inquiry process</td>
</tr>
<tr>
<td>4</td>
<td>Making predictions; Plan inquiry procedure</td>
</tr>
<tr>
<td>5</td>
<td>Plan inquiry procedure; Carry out inquiry; Discuss evidence and draw conclusion</td>
</tr>
<tr>
<td>6</td>
<td>Making predictions; Carry out inquiry; Discuss evidence and draw conclusion</td>
</tr>
<tr>
<td>7</td>
<td>Hypothesise; Plan inquiry procedure</td>
</tr>
<tr>
<td>8</td>
<td>Plan inquiry procedure; Make predictions; Carry out inquiry work; Discuss evidence and draw conclusion</td>
</tr>
</tbody>
</table>

After one of the later lessons where the concept of dissolving was explored through engagement in a group inquiry, Emma spoke about the ways in which she thought she had encouraged children to think scientifically through their peer group talk:

...their reasoning, they were arguing and discussing things with each other, disagreeing with things but that moved their learning on as well because they would be talking with each other and reasoning... when they started coming out with the questions that then, but then that wasn’t really group talk because then they started thinking by themselves... the ability to think, just the ability to justify whatever they’re thinking, I was hoping they were knowing that that’s what was expected of them and to be able to think outside the box as the term is. 

*EMMA ORAL DIARY 7*

Emma’s reflection again demonstrates her strong beliefs about the potential of group talk for developing learning which emerged during the initial interviews. However, what the group talk transcripts show is that in fact the children engaged in very low level dialogue in the eleven minute discussion task of planning an investigation. An illustration of the typical talk is exemplified in Transcription Box 6-1.

This peer talk is very agreeable and of course necessary in order for the groups to move on and carry out their procedure and it can be classified as having cumulative properties due to the uncritical building of ideas by the participants (Mercer, 1995).
Ellie: right we need to use just a little bit
Nathan: disappear in hot water
Sam: dissolve
Ellie: let’s do dissolve sand salt sugar and plain flour
Sam: does chalk dissolve in hot
Yvonne: water
Ellie: so what other materials shall we need shall we use
Nathan: do you remember when
Sam: can you remember when we were talking about megazone you had to wait 88 minutes you had to wait one hour and 28 minutes you had to wait
Yvonne: so shall we do self-raising flour yea we’re having chalk as well
Ellie: yea we’ll have sand

A little while later Emma reminds class to think about equipment:

Nathan: told you
Ellie: we need a cup
Sam: water
Nathan: water water what about water does chalk dissolve in hot water
Ellie: we need a cup of water
Nathan: we have to put what we need Sam
Ellie: 5 cups
Sam: chalk
Nathan: yes obviously
Ellie: I think this is all we need 5 cups and some water
Yvonne: yea
Ellie: no we need 4 cups
Yvonne: oh and a big jug yea
Sam: we don’t need anything else but we need a ruler
Yvonne: small cups oh we might need a spoon it doesn’t matter we’ve got some cups over there
Ellie: we’ve got big jug we need a spoon so what we are going to do is get them place them in the water Place all the chalk self-raising flour talcum powder in one and soil in one then we are going to erm
Yvonne: pour the water in
Nathan: I’ve got a joke knock knock
Yvonne: who’s there

At this point the conversation moved off task for a short while
However, of note is the difference between this talk and that which Emma reflected upon during her oral diary extract given earlier. Despite Emma’s strong beliefs about how peer group talk can challenge children to engage in reasoned thinking, the opportunity for dialogue that was provided which focussed on collaboration and procedure, did not give them scope to do so.

The same type of planning and conducting an investigation activity was assigned to groups in the final lesson where they were asked to explore the force of friction by testing a range of surfaces in their small groups. They were encouraged to share ideas and work as a group; the only other mention of the type of talk expected was at the point when Emma suggested to groups that they talk about and record the reasons for their choice of surfaces. This prompt gave rise to some justifications, a feature of Exploratory Talk, as the extract in Transcription Box 6-2 reveals.

What can be seen from this transcript is a number of justifications from the children with their use of the word ‘cos/because. Their talk is a consideration of a range of ideas and encouraged by Emma to provide reasons through their discussion, they extend their thinking to ensure that they have selected a range of surfaces for their test. On a number of occasions, Ellie can be heard to request the group to think; she invites a comment from Yvonne and questions the group about their strategy towards the end of the extract. This leads them to pick up on Sam’s first idea about the possibility of using sand and a justification for this is provided too. In this short extract we can see the group working in an exploratory fashion, critically engaging with one another’s ideas to produce a reasoned selection of materials for their testing. The whole of this episode was given four and a half minutes of the time from the lesson. Much of the rest of the time for the group talk was taken up with planning for testing and measuring. The extract in Transcription Box 6-3 is typical of the less exploratory and more procedural kind of talk in evidence through this part of the activity.
Ellie: we could choose a rough and a nice a nice surface in here and we
Sam: sand
Ellie: erm wait let’s do table ‘cos that’s like a smooth surface
Nathan: I’ll write table
Sam: carpet
Ellie: yea carpet
Sam: no ‘cos it’s like the astroturf
Nathan: outside
Ellie: and outside shall we do grass Yvonne what would you like to do what do you think
Yvonne: you know those things you balance on those logs
Ellie: but what about the gap it may fall off wait
Nathan: do rubber then
Ellie: wait let’s think

And a short while later after they have selected some more surfaces:

Ellie: wait we’ve got one soft surface we’ve got a lot of got like
Yvonne: a lot of hard surfaces
Ellie: shall we do instead erm instead of brick do
Yvonne: sand do sand
Nathan: sand yea sand
Ellie: because we have got a lot of hard things

Nathan: do we go outside what does this go up to Yvonne
Yvonne: er
Sam: let’s start on the table
Nathan: no wait you pull it like that
Yvonne: right let’s get everything ready first
Sam: 2 Newtons 5 Newtons
Ellie: wait no this is the first go you have to say what you got on the first go that was the last go
Nathan: what are you doing writing it on grass we are on the table
Yvonne: okay so we found how many Newtons
Afterwards, Emma reflected with confidence about the group talk in her classroom, relating it to the practice of working as a scientist:

... they’re sorting each other out with the vocabulary to use the right science language and just the fact that they’re talking about it means that they’re having to come up with words to explain it and the reasoning behind things and the group work idea as well of them taking it in turns, all that talking to communicating with each other, all of that’s coming through in the talking part of it so it’s not just science based it’s more the whole child, which is a science child.

...experiencing the science side of things, the actual talking about friction, choosing, helping each other choose the equipment and making the right choices for that and changing things that needed changing so they, they’re becoming real scientists I think in the fact that they’re trying things out but they’re not scared to try things out and then they’re thinking that didn’t work, what do we need to do to make that better or to make that work... they were finding out the answers and they were trying out other things.

EMMA ORAL DIARY 8

If we examine Emma’s ideas about being a scientist as reflected upon in this oral diary, there is a focus on procedure. Emma’s beliefs about children working as scientists perhaps frame them working and talking collaboratively through a procedure and the focus for the group talk was therefore often on this.

6.3.1.2. Arun

The first lesson of the project focussed on children’s understanding of circuits and part of it was taken with groups planning and carrying out their own investigation to answer the question ‘How can you make a bulb brighter?’ After a whole class teacher led discussion on the principles of fair testing, Arun offered the activity as a challenge to the groups and provided them a choice of resources to respond with. Two extracts (see Transcription Box 6-4 and Transcription Box 6-5) illustrate how the groups engaged in this task and the kinds of talk in evidence.

In the first extract the children talk their way through the task but the features of the talk are exploratory in nature, with children considering possibilities, making hypothetical statements and trying to elaborate their predictions, confirming and extending each other’s ideas about the brightness of the bulb.
Perhaps the nature of the discussion task set in terms of it being an inquiry for the groups to consider provided them with the scope to talk in these particular ways. Being asked to work through the problem of how they could make the bulb get brighter, allowed them to propose possibilities for action and explore their ideas, if only briefly. However, during the first oral diary entry when reflecting on the aims for the peer group talk in this lesson and how it had facilitated learning, Arun did not mention that this had been his plan and instead referred to children talking about...
their activity as being the where learning through talk had occurred, implying this was a focus for him:

*I thought it was generally pleasing that they actually got to experiment within a group setting and got to talk about what they were doing and so their language and use of scientific language was coming on.*  

Arun Oral Diary 1

His reflection perhaps indicates a belief that children getting talking about their group experiment will lead to productive dialogue. Indeed the extract above does show that this can be possible however this was nestled within a large amount of less productive talk, with children simply making observations about the bulb to each other and making decisions about who was to manipulate the equipment. An example of this kind of talk is given in the second extract from this lesson (Transcription Box 6-5).

Transcription Box 6-5

```
Beth: so shall we change the amount of batteries
Oliver: yea
Nigel: yea put 5 batteries in it
Oliver: you going to connect that
Beth: eh ah let me have a go let me have a go
Oliver: you can’t connect it without a piece of tape
Lucy: I know how to connect it
Beth: I’ll connect it I’ll properly connect it
Lucy: I know how to connect it
Nigel: I’ll be a lot quicker…..There you go
Oliver: yeah but it will spring off and it’ll hurt your fingers Nigel seriously it will just spring off
Beth: yes it’s coming on
Oliver urg it’s not even bright
Beth: my turn my turn
```

Arun Pupil Group Talk Lesson 1

The talk in evidence here is typical of the kind revealed by the entire transcript as children engaged in carrying out the practical tasks Arun set. Whilst children are generally collaborative and the kind of talk in evidence is necessary in order to work productively, the critical exchange of ideas which is central to the development of understanding (Barnes, 2008, Mercer and Littleton, 2007) cannot be heard. Arun’s
reflection after the second lesson again demonstrated beliefs about group talk as a vehicle for children to work collaboratively through an inquiry:

...actually doing it more practically and getting them to talk about it is effective because they are enthused.

Arun Oral Diary 2

However, again the talk emerging from this part of the lesson was procedural as children talked around their activity. The third lesson (for a detailed analysis of peer group talk from lesson 3 see Appendix 9.6b p.364) also drew on an inquiry approach and Arun reflected upon the fact that the task gave children ‘the opportunity to talk’

Arun Oral Diary 3. The data from these three lessons suggest that Arun held beliefs about the importance of talk and also that inquiry learning is a relevant approach through which to engage children in discussion but that his motivation for doing so lay in issues around involvement and engagement.

In the fourth lesson, based around the force of friction, Arun again employed an investigation for the groups to talk through. Arun focussed on systematic testing procedures in his whole class discussion and this perhaps is evidence of beliefs about science being a process of inquiry (Bartos and Lederman, 2014). Cumulative talk was once again revealed by the transcripts (for a detailed analysis of a typical sequence from this lesson see Appendix 9.5, Extract 5 p.357) and this is perhaps in line with Arun’s belief about children simply talking through an investigation. In the oral diary after the lesson Arun refers to his planning for talk:

...in planning the investigation I am still not sure that they are talking enough. I want them to talk a lot more and I want them to behave sensibly and take turns and get everyone to talk and help each other so it’s just trying to get them to work in teams.

The practical nature of the experiment was good, they were really engaged and they enjoyed doing that and they could be systematic in doing the experiment and just the scientific way of working.

Arun Oral Diary 4

These comments demonstrate that Arun’s thinking about talk here is simply on the level of collaboration and action (Alexander, 2008c). His focus is on the amount of talk and that it is collaborative so they can work through the set activity, rather than the cognitive quality and content and this is perhaps related to anxiety about pupil behaviour that has been highlighted in a previous chapter.
6.3.1.3. Simon

Simon also drew on inquiry activities as a location for group discussion tasks (Table 6-3) demonstrating his espoused beliefs about science being a process of experiment and inquiry to confirm knowledge. At points during lessons Simon also made explicit to the children these beliefs about science with comments such as:

Simon says to the class ‘you are doing science and science is about proving something’.

Simon said that this is science and it is about testing ideas, not taking things for granted.

<table>
<thead>
<tr>
<th>Simon Lesson</th>
<th>Inquiry skill required for group talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Carrying out practical inquiry work</td>
</tr>
<tr>
<td>2</td>
<td>No inquiry activity in lesson</td>
</tr>
<tr>
<td>3</td>
<td>Formulating questions; Planning inquiry procedure; Carrying out practical inquiry; Discussing evidence from inquiry and drawing conclusions</td>
</tr>
<tr>
<td>4</td>
<td>Carrying out practical inquiry; Hypothesise</td>
</tr>
<tr>
<td>5</td>
<td>No inquiry activity in lesson</td>
</tr>
</tbody>
</table>

The first lesson, which has already been described and discussed in the previous chapter in relation to features of pupil ownership, had a focus on carrying out the practical element of an inquiry and this included the skill of fair testing. Afterwards, when prompted to reflect upon how group discussions had been facilitated and how learning had been planned to take place through them during the lesson, Simon made reference to organisational issues and collaboration ‘making sure they all had equipment... getting everyone involved...on the whole there was engagement...actually they were all quite pleasant talking to each other’ Simon Oral Diary 1. An emphasis on peer groups talking about their activity was noted during the observation:

A lot of time on the activity; children are required to organise themselves and carry out their test. Emphasis is on the procedure. Simon says ‘talk about what you are doing’.

The extract in Transcription Box 6-6 is typical of the group talk in evidence throughout this first lesson.
Mark: we are not using bubble wrap ah man
Tom: right next is fluffy carpet
Mark: next we’ve got fluffy carpet
Evan: okay that’s the bit
Tom: hold it okay build the house
Andrew: okay
Mark: do you want me to knock it
Andrew: no me
Mark: no Tom knocks it
Tom: okay is the whole team ready and off we go
Mark: 1,2,3,4, 3
Tom: bang bang
Mark: no wait you did that well hard
Andrew: make it the same
Mark: oh the carpet I wanna do the carpet next
Tom: that’s Mrs Brindley’s old carpet
Mark: is it
Andrew: no it isn’t it’s Mrs Walker’s
Tom: oh yeah Mrs Walker’s

Simon Pupil Group Talk Lesson 1

This extract shows that although the group made reference to the fair testing element of the task, the focus was on how they could collaborate to get the job done and the talk became a commentary on what should happen; after all this is what Simon had asked them to do. The range of data demonstrates a focus on procedure and activity for the group talk and also perhaps is evidence of Simon’s beliefs about science being a process of collaborative and cooperative experimentation (Osborne et al, 2003).

6.3.2. Science talk for vocabulary

6.3.2.1. Arun

The oral diary entry after lesson four suggested that Arun was concerned about taking an inquiry approach and it became clear that he felt he should use peer group discussion more to help the with the development of scientific vocabulary:
...they were still not secure in using some of the vocabulary and they need lots of prompting ...vocabulary is a big thing I think. I talk to Key Stage 2 teachers and one of the major problems with science teaching is that they are not secure with vocabulary at all, even getting ready to take their final year exams they are not secure with vocabulary but I think just plenty of repetition all the time would help them to pick up a vocabulary ... the scientific vocabulary is always a problem in science teaching, to get them to use the correct vocabulary and be confident to use that. I think that can only come with repetition really.

**ARUN ORAL DIARY 4**

Although he had beliefs about the benefits of children engaging in dialogue within inquiry contexts, these comments reveal that Arun felt this was not providing him with the evidence of learning which he required in terms of children using scientific vocabulary. An apparent tension between Arun’s beliefs about science learning seem to have surfaced through the process of working to engage pupils in inquiry (Golding, 2013, Ovens, 2002) and in some of the following lessons Arun’s more product orientated beliefs about science learning are prioritised through his application of peer group discussion:

\[ It was all about vocabulary and it’s the practice of vocabulary really and just repeating the words and using the correct words for the right property, so that was my intention to purely focus on the vocabulary. \]

**ARUN ORAL DIARY 5**

### 6.3.2.2. Simon

Simon’s focus on vocabulary was evident at points through the project. During the second lesson on food chains which has already been described in a previous section, the children were not given opportunities to discuss ideas in groups but provided with independent worksheet activities to complete alongside their peers. When prompted to think what kind of talk he was hoping for Simon suggested that it was simply:

\[ ...using the technical vocabulary really...so they understood what they were talking about and I think it was using those technical words would demonstrate that. \]

**SIMON ORAL DIARY 2**

This is perhaps further evidence that Simon held beliefs of science as knowledge and learning science as developing knowledge of and confidence with scientific terminology. In fact, he placed an emphasis on the importance of vocabulary throughout the project and in later lessons returns to the point:
...the vocabulary so it’s built on the vocabulary that they’ve been using...I was hoping to hear vocabulary, I was hoping to hear most of the vocabulary.

**SIMON ORAL DIARY 3**

... (the group talk) was great because you could get them to the right answer and give them the vocabulary but that was part of the learning process.

**SIMON ORAL DIARY 4**

...the discussion to some extent to assess whether they’re with it as well and if vocabulary was pushed in there.

**SIMON ORAL DIARY 5**

### 6.3.3. Science talk for authentic inquiry

#### 6.3.3.1. Emma

Project lesson five in Emma’s class has already been described in some detail in Chapter 5 where the apparent change in emphasis towards greater pupil ownership has been highlighted. The groups had been asked to plan an investigation into which materials were most insulating and would keep an ice cube from melting but during this lesson an additional facet of inquiry became the focus for peer group discussion. Part way through, as pupils were carrying out their plans, Emma spoke to me and commented that she was unsure how to proceed, despite having covered this content as a class for a number of years previously. It seemed that requiring children to work and talk it through in independent groups in a way she had not done before, had created a dilemma around how to come to a whole group consensus with the correct answer about the most insulating material. She was satisfied with the way in which all the children were collaborating on their investigations and that they were talking productively in this respect yet was clearly concerned that she had a conceptual message to portray and that it was becoming difficult to draw the children to her learning goal because they had all gone in separate directions with their inquiries. After spending some more time moving between the groups, Emma’s resolution to this problem was to bring the class together and lead a discussion focussing on how pupils could begin to transform their results into a conclusion. She then presented the groups with some issues to discuss:

*Emma: According to your experiment which material is better at keeping the ice cube cold? Look at the ice cubes now, your results. Can you collect an actual*
answer from them? Some groups have still got ice cubes. Maybe, I don’t know, does this mean their experiments are better? It’s quite interesting.

TAKEN FROM EMMAS LESSON RECORDING 3

She asked the children to visit other groups’ ongoing investigations to find out what they were doing, look at the results they were getting (how well the ice cubes were being preserved by the different materials) and ask each other questions about what they were finding out. They were encouraged to request information about observations and evidence. Afterwards, when prompted to reflect upon the decisions she had made before and during the lesson with regard to the group talk, Emma referred to this episode and said:

I didn’t know how they, what they were going to come out with particularly, even though I have done this for the last few years, I didn’t know how it was all going to play out so I didn’t know how it was going to come together, how it would play out and I didn’t really plan that bit and them going around and sharing what they’d found out but I knew I needed to pull it together in some way. I knew what I wanted to do, get what each group had found out and what they wanted to change, but I think that helped as well with them talking and seeing what the other groups had done and realising that maybe there are other ways of doing things and they got the same sort of results really.

EMMA ORAL DIARY 5

The risk taken by Emma through her construction of a more complex educational environment had reduced the predictability of the context and seem to have created awkwardness and uncertainty about the ‘right’ way forward (Fook and Gardner, 2007). Through her reflection in action (Schon, 1983) which arose as a result of her uncertainty about how to proceed within a lesson, Emma demonstrated wider beliefs about science; no longer simply a practical endeavour, no longer just facts to be picked up but a mental activity of inquiry involving the use of evidence to come to conclusions (Harlen, 2013, Chinn and Malhotra, 2002). Emma also seemed to be talking about this activity in terms of children beginning to know that the inquiry process can be creative, that different scientists may go about things in different ways, trying ideas out and being innovative whilst still looking at the same question thus revealing a different facet to her belief about science (Bartos and Lederman, 2014). In this way, Emma’s reflection caused her to consider differing perspectives, draw tacit assumptions to consciousness and select her course of action based on a more broad set of beliefs.
The pupils also commented in positive ways about this part of the lesson in their group interview:

*Harry*: I learned most in the part where we got to see and talk how what like everyone was saying like it’s not good this material because we actually got to think about some of the other materials

*Sam*: basically where we when we got to go into groups and look at each other’s and that and then they asked us questions and that and we had to answer them

*Ali*: they wanted to touch stuff and see how small it was and how big it was and tell us loads of questions like why did you do it like that

*Harry*: yea because then you say something and then they can build onto it…it got me interested

*Ali*: it you didn’t talk or anything you’d just write stuff down and other people wouldn’t know if you were agreeing

*Emma Pupil FG Interview 5*

Throughout the lesson the recordings of the group talk revealed less questioning from other children than perhaps these pupil interview extracts may lead us to initially believe, although perhaps this goes some way to demonstrate the power this particular experience held for the pupils, that they perhaps therefore over emphasised what occurred. However, the transcripts of group discussion did show that the children made constant reference to their emerging results and worked to formulate conclusions about their selected materials as Emma had requested. They framed their comments about the materials in terms of winners and losers and the children transforming their observations into initial conclusions can be seen in an example of their talk (Transcription Box 6-7).

*Transcription Box 6-7*

*Ellie*: okay let’s see
*Yvonne*: is it ice
*Ellie*: no not really
*Ali*: finally the bubble wrap is losing on ours then
*Ellie*: it’s still got ice in
*Yvonne*: it’s big
*Ali*: well tin foil’s the best

*Emma Pupil Group Talk Lesson 5*
However what was interesting was that through the dialogue the groups also began to think about their test and consider its flaws. They were prompted to do this through interaction with both other children and Emma and through their own experience of carrying out the procedure they had planned. The encouragement from Emma to engage in an open dialogue about the way their test was progressing perhaps enabled them to talk in ways which demonstrate evaluative features of authentic inquiry (Chinn and Malhotra, 2002) as can be seen from the following extracts of transcript data (Transcription Box 6-8 to Transcription Box 6-15). I will now explore each of these transcripts in more detail.

After the group had covered their ice cubes in a range of materials and had observed them over the course of about half an hour, they began to discuss their testing procedure (Transcription Box 6-8). The transcript is not from one continuous sequence of talk and I have indicated where other discussion was occurring.

In the first part of the extract the girls begin to air their uncertainty about the way that they have set up their test. This begins with Ellie’s concern that there is a hole in one of the ice cube’s wrapping, an idea which is elaborated upon by Yvonne as she connects it to the issue of needing to have a fair test. When questioned by another child, Ali begins to infer a preliminary result from their test and Yvonne connects her observations back to a previous investigation when groups tried to keep hot liquids warm with insulating materials. Ellie continues with her evaluation of their test by analysing the temperature reading so far which is perhaps higher than they were expecting and Yvonne builds on this offering a hypothesis as to why they are getting high readings, suggesting that perhaps their thermometer was not positioned correctly. The second short sequence sees the group offering their ideas about making conclusions, which is what Emma has asked groups to consider. This begins with Yvonne asking a question to get the group thinking and interestingly, rather than giving a result, Ali offers a generalised statement with which they can analyse their ice cubes. They are then challenged by Ellie who seemingly reminds the group about the status of a conclusion.
Ellie: I think we should plug that gap up because that’s probably the gap that’s making it er
Yvonne: that’s not making it a fair test
Ellie: we need to just quickly get it taped up
Other child: have any of yours melted yet
All: no
Ali: bubble wrap’s still massive
Yvonne: it’s a hot one too bubble wrap is actually a good material
Ellie: if we have put it in the right places I don’t know if we have because it’s 4 Celsius
Other child: can we see yours
Ellie: no it’s not open
Yvonne: they are both left just see them but maybe it wasn’t touching or in the right position

Later

Yvonne: okay so what’s the conclusion
Ali: the one that melts faster is the loser
Ellie: we haven’t finished yet so we can’t do the conclusion

Later

Yvonne: how are these temperatures dropping
Ellie: er
Ali: what
Yvonne: how are these temperatures dropping
Ellie: cos like yea I know cos that’s meant to be
Yvonne: dropped it was higher and it’s gone back up again
Ali: yea and gone back down again ‘cos it got cold
Ellie: it’s cold its cold
Ali: yea maybe but the sun is shining on it so let’s think

In the final sequence of this transcript, the group again begin to evaluate their emerging data and show concern about their results. They had not been asked to specifically make predictions in this lesson but it is possible to note from their discussion of the temperature changes that they had ideas about what might happen which were possibly based upon the previous investigation with warm liquids. The
short sequence is evidence of the group spotting another possible flaw with their experiment; they do not resolve this because after Ali suggests the group think further around the anomaly, the teacher calls time to finish off and tidy up. Through these three short extracts, it is possible to view the group as working like scientists, the way they make links to other inquiries, make generalisations, interpret their data, link observations to predictions and evaluate their testing procedures (Chinn and Malhotra, 2002). The group work collaboratively, attempt to make explanations, although briefly and take up each other’s ideas, exploring their meaning and therefore the talk displays some exploratory features.

During the same lesson, the group of boys had decided to measure the rate of melting by checking on their ice cube every ten minutes, drawing what it looked like and they had decided that the ice cube which melted first had the ‘worst’ material. The group had talked about the materials and the ice cubes in terms of a race, with winners and losers. A transcript of their talk is given in Transcription Box 6-9 and this shows that the group seem initially very confident about their choices about measurements. Their dialogue follows the same line of thinking, showing that they are all engaged in talking about what they need to achieve and they appear proud that their ice cube is still so large compared to others they have seen around the room, although Harry notes at a couple of points that perhaps they will be waiting a long time to get a conclusion.

Transcription Box 6-9

Nathan: I think ours will last the longest
Sam: ours is giant still about this big
Harry: this will take ages
Sam: ours is this big
Harry: they’ve probably made it more hot
Nathan: we’re winning their table’s covered it they’ve covered it and it’s dead
Harry: they haven’t got a good way to measure it
Nathan: oh well its melted
Harry: but our job isn’t done
Nathan: ours is okay ours is like a giant
Harry: we will be waiting for days and years until my leg falls off
Later on one of their classmates questions the group about their plans for measurement of the rate of melting (See Transcription Box 6-10).

Transcription Box 6-10

Other: have you got a thermometer
Harry: no we haven’t got a thermometer
Nathan: we used one last week
Harry: you’d have to break a hole in it in the ice to measure it
Nathan: have all of them wait I think the bubble wrap is just er almost melted
Sam: it’s ice it’s still ice what about tin foil
Nathan: I think they are still ice
Sam: yea
Other: is that all you are doing
Sam: yea

EMMA PUPIL GROUP TALK LESSON 5

When questioned two of the group attempt to justify their decision about not using a thermometer. Nathan seems defensive perhaps, letting their peer know that they have used one before but Nathan also adds more specific reasoning but this does not satisfy the interested other classmate. He probes again at the end perhaps suggesting to the group that they could have a more complex arrangement and this idea is something that the group pick back up later. Before that however their teacher, who was listening in to the group making their observations and beginning to interpret their results, also questions their measurement strategies (see Transcription Box 6-11). This leads the group to begin to consider new ideas about how they could collect their data.

A little later the group are prompted again to return to the discussion about the issue with their testing strategy and Transcription Box 6-12 reveals how Harry picks up the idea of using a thermometer which was proposed earlier on by their classmate. The rest of the group seemingly ignore the idea however and continue with their pictorial mapping of results.
Transcription Box 6-11

Sam: they’re all ice still
Harry: ah I think that one is feeling big
Sam: it’s melting
Harry: it’s winning the foam is winning
Nathan: the foam is losing
Harry: no foam hasn’t even turned to a little bit of water
Emma: is seeming bigger a scientific measurement it just looks bigger
Two voices: no
Emma: I’ll leave you to think about this is there another way of measuring

Pause

Sam: measure the water it’s too late we’ve not done that
Harry: but we’ll have to measure the water
Sam: we will have to start again
Nathan: it’s too late

EMMA PUPIL GROUP TALK LESSON 5

Transcription Box 6-12

Other: look at ours look at ours look how much is still there
Sam: it’s kind of the same
Harry: ours hasn’t melted yet when it melts when it melts
Nathan: but we’ve got to wait two hours
Harry: yeah but when it melts we could measure it the one with the highest er with the lowest er the highest temperature is the loser
Sam: its 45 minutes Nathan write this one down
Harry: we could have a thermometer

EMMA PUPIL GROUP TALK LESSON 5

After this sequence, the dissatisfaction becomes more apparent and Transcription Box 6-13 demonstrates how Sam makes explicit an evaluation of their strategy which has been brewing through the previous dialogue.

A little later, Sam calls the group’s attention to the task Emma set — to consider how well the materials insulate the ice (see Transcription Box 6-14). Sam’s question in the first line, leads briefly to dialogue around the emerging results but then returns to the
ongoing concern about the time it is taking for the ice to melt and the impact this is having on the group being able to use the evidence to draw a conclusion. However, what Harry does do is formulate a generalisation which is perhaps as a result of the group’s sustained thread of dialogue around their measurement strategy.

**Transcription Box 6-13**

Sam: *why is everyone looking at ours*
Harry: *because ours hasn’t melted we are famous now okay I think we have the best idea of what to do*
Sam: *yea but the measuring idea wasn’t good*
Nathan: *it’s gonna take ages*
Harry: *I’m wishing ours was melting now*
Nathan: *it lasts for ever*
Harry: *it won’t last for ever*
Sam: *it’s literally been oh none of them have melted urgh we’ve still got a giant ice cube*
Harry: *what do we do then we will be recording everything for ages*

*EMMA PUPIL GROUP TALK LESSON 5*

**Transcription Box 6-14**

Sam: *what’s our weakest point what’s our weakest one*
Harry: *bubble wrap not tin foil tin foil’s the best*
Sam: *it’s bubble wrap but look look*
Harry: *it’s almost been an hour*
Sam: *48 minutes and its barely melted*
Harry: *we found out that the ice doesn’t melt very quickly*

*EMMA PUPIL GROUP TALK LESSON 5*

Soon after Emma arrives at the group’s table and Sam shares the frustration they are feeling, Emma again prompts them to evaluate their strategy as she had done in the initial setting of the task (see Transcription Box 6-15).

During this sequence the group takes action and begin to utilise a different way of collecting data by using a thermometer, an idea which has been explored in the dialogue at earlier points. The question by Emma prompts them once again to return to their evaluation and for Nathan to draw on the earlier idea of using a thermometer.
and they make a reasoned decision to continue with their current measurement and also record temperature changes numerically. The set of extracts (Transcription Box 6-8 to Transcription Box 6-15), which occurred at points throughout the lesson, shows that the groups had a strong engagement with the idea of how they may reasonably collect their data. The discussion task Emma set required the groups to not only to translate observations into conclusions but also to consider the validity of their test. The ongoing experience of the ice taking a long time to melt and the input from both their classmates and Emma which questioned their strategy for measurement enabled them to work in a scientific way, consider other options and make reasoned decisions; to work in a scientific manner.
After the lesson Emma reflected upon the learning she thought had taken place:

The whole experiment thing and them trying stuff out and failing but that it’s alright to fail, to change things and learn from things and that’s how scientists are and to get them to think about how they could improve it...that was one theme and then the other theme was the science theme of finding out about insulators.

They were learning about group dynamics, they were sharing, they were working together, questioning themselves, backing up their reasoning, using what they learnt before to help them, there was so much in there and a bit of science as well, thankfully because it’s science.

These two comments perhaps provide insight into dualistic aspects of Emma’s beliefs about science and science learning (Bryan, 2003, Wallace and Kang, 2004); how that in planning for peer group talk Emma drew upon ideas about science as a body of knowledge but also of it as a socio-cultural practice of dialogic inquiry (Wells, 1999). She appeared to experience tension between her beliefs about pupils gaining new scientific knowledge and being able to identify good insulators, a low level epistemic operation and pupils being encouraged to use evidence to draw conclusions and evaluate their ideas, both higher level epistemic operations (Christodoulou and Osborne, 2014). Emma’s seemingly productive resolution to the problem appeared to rest on her selection of an inquiry process as a specific aim for the dialogue, rather than allowing dialogue to simply occur around the inquiry.

Later in the study Emma again made reference to her dualistic beliefs when she was reflecting upon the way in which she required children to engage in discussion in order to come up with their own questions for inquiry, something which she said she had never done before:

The main learning was dissolving then also that we can have questions that we can investigate was the other side to it so we can always have questions and that’s the other side to it, that’s something that has come up more in my teaching this year, let’s see what happens, that whole I wonder if, so developing that side of things so there’s two sort of problems with me, one the scientific side experimenting and coming, bouncing off each other, getting ideas and the other side it the actual principle.

During the sixth lesson Emma again used group discussion for more than just planning investigations. The lesson had the learning intention of developing pupils’ ideas about
properties of solids and Emma provided a group discussion activity that she had never tried before in an effort to get her pupils to think about how solids can change shape yet conserve their weight. After a brief review of previously discussed properties Emma provided groups of children with an example of a solid in a jug (the range included foam, play dough, grass, paper strips and cotton wool). She asked the pupils to consider how much of the solid there was, how much space it took up and how heavy it was. Once they had discussed this, they were asked to predict what would happen to their measurements when they squashed the solid and the plan was for children to then use evidence from measurements of weight to construct explanations about what they had observed. Although at times during the lesson, there were practical issues with the equipment (meaning there was limited success with the activity) and challenges for Emma’s subject knowledge what was interesting was the approach to the use of group discussion that she took. There was a focus on prediction and the use of evidence to create explanations for observations that I had not observed to date and by trying something completely new Emma demonstrated confidence and enthusiasm for the confluence of dialogic activity and scientific inquiry.

The recordings of children’s discussion about their predictions around how much cotton wool they had, revealed talk which demonstrated some interesting uncertainties for the pupils. Transcription Box 6-16 shows the pupils considering the solid they have been given and how much they have.

Yvonne begins with an expression of her thinking about the property of the solid they have been assigned and Nathan adds his observations. Ellie appears to generate discussion by restating her teacher’s question and this prompts Nathan’s suggestion that the solid won’t weigh anything. At this point, Sam makes his one contribution challenging this. Ellie seems to take this idea as she attempts to make a prediction but does not finish and after Emma’s prompt it is clear she still remains unsure. This extract shows how the group are clearly listening to each other’s ideas and building upon them but there is also a creative uncertainty evident in their discussion as they puzzle over their solid in this open ended assignment. There are a number of features of Exploratory Talk within this extract as children provide information for
consideration by the group, offer challenges and contrasting ideas, give justifications and attempt to come to a consensus.

Transcription Box 6-16

Yvonne: the cup is going to weigh more than the actual solid itself the cotton wool itself is really like soft and light
Nathan: but it is taking up more space
Ellie: what do we think it will be
Yvonne: well the actual thing will probably weigh I don’t know
Nathan: you’ll have to take it out
Ellie: yea
Nathan: because this is more weight
Ellie: yes ‘cos then it will put more weight because this is really soft and light
Nathan: that will be nothing that
Ellie: yea
Nathan: this will like be nothing
Sam: it weighs something
Yvonne: you have to take it out ‘cos then you are measuring the pot
Ellie: I think it will weigh like
Nathan: it’s a bit too long
Yvonne: I don’t really know it doesn’t weigh anything really
Ellie: yes it will can I feel it
Emma prompts the class to jot down their estimate
Ellie: we don’t think it weighs like it’s just really light we don’t think it weighs anything
Yvonne: it’s got to weigh something it’s probably going to weigh something like 1g
Adult: well talk about it and write down your measurement no not your measurement your estimate
Yvonne: If we pick it up it’s really light
Nathan: what’s our estimate
Sam: how about 2g

EMMA PUPIL GROUP TALK LESSON 6

Towards the end of the lesson the groups were asked to squash their solids so they took up less volume and then to consider in groups how they thought the weight may have changed. As is illustrated in Transcription Box 6-17, Emma encouraged the groups to provide explanations for their ideas. For this task, the group divided themselves into two pairs.
Sam: with squashing  
Nathan: you think it will weigh less  
Sam: I think it will stay the same  
Nathan: you think the same  
Sam: yea may be a little bit less  
Nathan: yea like to 19  19 or 18  
Sam: yea  
Nathan: we wanted it to be 2g so it might go down 2g to 18  

Pause  

Nathan: but air could go into this and make it heavier  
Sam: Nathan our second estimate is about 18g

This extract is brief because Emma did not give the children long to discuss the question. However, before Sam closes down the dialogue with his decision in the last line of this extract the boys shared their ideas and related thinking back to the original estimate at the start of the lesson. It seemed as if the boys had agreed on an idea but some thinking time allowed Nathan to offer a new one, one which he provided a reasoned position for. This explanatory type of contribution is a feature of Exploratory Talk and is what Emma had been hoping to hear when she asked for explanations to be attempted, however perhaps the short amount of time given meant that Sam felt compelled to go with the previously agreed option. The other pair in the group also attempted to consider the question. After a significant period in silence Emma prompted this pair again (see Transcription Box 6-18) and in a short space of time they also responded to the task with well-formed reasoned thinking.

Emma: do you think it will weigh less now the volume is less  
Yvonne: er well yes  
Ellie: no because it’s still the same you’ve just squashed it down  
Yvonne: erm when you squash it you squash the air out so you are making it less heavier
After the lesson Emma reflected upon how she had used peer group talk and her focus once again remained upon the sharing of ideas and the encouragement of children to give reasons. Interestingly, there was no mention of the fact that she had applied her beliefs about the potential of group talk to different operations within the inquiry process:

What I got from it was good science...you could see from the sharing of information you could see them learning from each other and picking up bits...sort of saying no I don't agree with this and you know correcting each other but in a nice supportive way, helping each other so those conversations where they were listening to each other, sort of challenging each other and backing it up with a reason. One thing I will always encourage is that learning from each other positive challenge. 

Emma here once again espoused strong epistemological beliefs about the role of collaborative dialogue in the learning process of this lesson. These beliefs are constructivist in nature and they highlight the importance of group discussion as a milieu which allows learners to negotiate differences (Tobin and Tippins, 1993). These beliefs, which are consistent with the philosophical underpinnings of the pedagogical approach under study in this project were in evidence the start of the study and continued to be explicit throughout as Emma explained with clarity how she believed talk could be beneficial in enabling children to probe their own ideas and develop understanding. These particular beliefs did not appear to develop further over time and although productive sequences of dialogue emerged from the groups which were in line with what Emma aimed for, there was also evidence that her hopes for what peer group talk could achieve were not always realised through the learning tasks set. The evidence from some of the group talk transcripts suggest that having strong constructivist beliefs about the importance of dialogue is not enough to consistently facilitate fruitful discussion in the classroom and that perhaps lack of clarity of the use of inquiry as a learning aim in itself (Ryder, 2011) may a provide constraints to effective facilitation of peer group talk.

The oral diary reflections over time revealed the steadfast nature of Emma’s beliefs about the productive role of collaborative dialogue, however her practice of planning
for and trying out some new opportunities for peer group discussion through higher level epistemic activities such as questioning, justification, evaluation, explanation and use of evidence for drawing conclusions are perhaps an indicator of a process of developing thinking; of Emma reframing learners (Pimentel and McNeill, 2013), seeing them not just as constructors of scientific understandings but as participants in the exploratory practice of science (Lemke, 1990). In this way Emma appears to have developed a dialogic inquiry stance towards learning (Wells, 1999) which acknowledges not just the critical engagement with one another’s ideas but also the relevance of wondering, questioning and the use of evidence.

In fact at the close of the study Emma talked about what she believed was important for group talk in science and made reference to the children as scientists. There was an emphasis on how talk related to the process of science in a more holistic way than had been initially espoused and this possibly reveals Emma’s new ideas about the purposes of science learning:

…it’s okay to say what you think, if you’ve got a reason for it then back it up with a reason. No scientist’s got to where they are by getting everything right all the time, they tried and getting those messages across to them that you’re not necessarily going to be right, but it’s the thinking and the reasoning behind it...I wonder why this happens or that happens because of this, it’s training them up to think that...they are scientists, they’re finding, they’re wondering about the word, what is a scientist? In my eyes it’s somebody who asks a question about the world and tries to find the answers by whatever method they can think of to do it, so that’s really what we’re trying to get the children to be I would say, I might be wrong but hey, I’m going for it I’m tainting my world with it and I think for them to see that that’s what happens with real life scientists then I think that’s important for them.  

Emma Final Interview 1

6.3.3.2. Arun

Arun provided inquiry contexts for group discussion tasks throughout the project as can be seen by Table 6-4, which perhaps demonstrates his beliefs about science being knowledge emerging through empirical work which were apparent through the initial interviews. What is interesting to note from the table however, is the shift towards the end of the project away from children being required to undertake group discussion tasks located in an inquiry based setting.
Table 6-4: Inquiry focus in Arun’s lessons

<table>
<thead>
<tr>
<th>Arun Lesson</th>
<th>Inquiry skill required for group talk</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Planning inquiry procedure; Discussing evidence from inquiry and drawing conclusions; Carrying out practical inquiry</td>
</tr>
<tr>
<td>2</td>
<td>Making predictions; Carrying out practical inquiry; Discussing evidence from inquiry and drawing conclusions</td>
</tr>
<tr>
<td>3</td>
<td>Planning inquiry procedure; Carrying out practical inquiry; Discussing evidence from inquiry and drawing conclusions</td>
</tr>
<tr>
<td>4</td>
<td>Carrying out practical inquiry; Discussing evidence from inquiry and drawing conclusions</td>
</tr>
<tr>
<td>5</td>
<td>Carrying out practical inquiry</td>
</tr>
<tr>
<td>6</td>
<td>Making predictions; Planning inquiry procedure; Carrying out practical inquiry; Discussing evidence from inquiry and drawing conclusions</td>
</tr>
<tr>
<td>7</td>
<td>No inquiry activity in lesson</td>
</tr>
<tr>
<td>8</td>
<td>Consider inquiry process</td>
</tr>
<tr>
<td>9</td>
<td>No inquiry activity in lesson</td>
</tr>
</tbody>
</table>

Despite focussing his use of peer group talk away from inquiry activities towards the end of the study there were still times when Arun drew upon this approach. Lesson six centred on understanding absorbency. After a group discussion starter activity to remind pupils of their previous work on this concept and review definitions, Arun asked the children to examine a range of materials and investigate which was most absorbent. Throughout the activity, the children were asked to think about their inquiry in more depth than had previously been observed. Arun broke the session down and focussed the children’s discussion around particular features of inquiry. In addition he gave additional guidance for the groups on the way in which he would like them to talk:

*Arun says he will give an outstanding octopus sticker for children providing reasons for their predictions which are based on evidence or prior knowledge.*

_ARUN LESSON OBSERVATION 6_

An example of Arun focussing the talk task in this lesson on a specific feature of inquiry is when he gave the group a set amount of time to consider their prediction (see Transcription Box 6-19).
In this extract, as they talk, the group were picking up and feeling the range of materials that have been chosen for testing. In turn they offer their predictions about which will be the most and least absorbent and they all attempt to provide some level of justification for their thinking to the group, as instructed by Arun. Initially these justifications are broad, with Beth and Nigel just hinting that they have reasons as they challenge one another’s predictions. When Oliver joins the dialogue he does so with a more precise idea of why a material may be most absorbent and in doing so draws on a definition of absorbency which has been developed in earlier lessons and reviewed in the lesson starter. Nigel seems to follow Oliver’s lead on using their joint understanding of absorbency by contributing with his more elaborated second justification which also links to his observations of the material. Although the group do not arrive at a consensus, they exchange ideas dynamically and somewhat critically such that exploratory features of dialogue are seen, for example assertions, brief challenges and counter assertions with justifications. At a later point in the lesson Arun
asked groups to focus discussion on how they were going to keep their test fair.
Transcription Box 6-20 is taken from this discussion.

Transcription Box 6-20

Oliver: *same amount of time soaking in the water*
Nigel: you need the same the water
Oliver: *the water the same do you want to talk Beth got any ideas*

Pause

Nigel: *probably could have time the same time in water time the same*
Oliver: *time to soak time in soak time of soaking*
Beth: *right you’ve got to keep everything the same*
Nigel: *what you have to keep the size the same*
Beth: yea
Oliver: *okay keep the size the same okay*
Beth: *you’ve got to keep the size the same*
Nigel: *I’ve got one*
Oliver: *yea you wanna keep the size the same*
Nigel: *I’ve got another good one*
Oliver: *you don’t need to keep anything else the same*
Nigel: *mmm the tray the same me the same (laughs)*
Beth: *the water the same, the time the same and the size the same of these er*
Oliver: *the paper the test paper whatever*
Beth: *the resources*
Oliver: *the resources*
Teacher: *when you say water the same what exactly about the water*
Nigel: *water the same ‘cos if we have a different amount of water if it like the amount of water because*
Teacher: *amount of water*
Nigel: *because if you put like forty ml in one and then fifty in another it might not it won’t be a fair test because one has more than the other*
Oliver: *If you suck it up the same but it has a different recording*

Initially this sequence of dialogue displays properties of cumulative talk (Mercer, 1995) with the group simply adding more ideas or reformulating ideas already expressed and when invited to contribute, Beth seeks to collect what she has so far heard from the others and formulates the current consensus. Her generalisation is briefly challenged
by Nigel’s specific question about the size of the paper but the momentum of consensus construction about ‘keeping everything the same’ is too strong. Arun appears near the group at this point, listening in and he prompts the groups to think more deeply about one of their suggestions, highlighting his earlier strategy of trying to get the children to provide reasons for their contributions. This prompts two members of the group to engage more strongly with their ideas about the fair test, to provide justifications and elaborated reasoned responses to each other and therefore talk in a more exploratory way about their inquiry.

After the lesson Arun reflected upon his aims for the group talk:

*I mainly wanted to concentrate on the fair testing side of things and planning for that so we did a lot of discussion on that. I tried to make it so that the talk was more fruitful in short bursts rather than just have one long period of talk and then they could keep the focus... they were actually thinking about the different elements...maybe they understood why we need to do that as scientists, so that was a good bit of scientific understanding in what scientists do to test things.*

Arun Oral Diary 6

What appears to be different from Arun’s reflection here is that he had moved away from a focus of engagement and getting children talking around procedure, to thinking about the content and quality of the talk. He made planning decisions which allowed him to concentrate on marking out for children the specific features of inquiry he wanted them to engage in. He gave them guidance on the way he expected them to talk and he intervened in the group when he heard that they were not giving reasons and elaborating their thinking for each other enough. The focus on using talk to consider features of inquiry emerged again during lesson eight where although the children did not work practically themselves through an investigation, Arun asked them to evaluate a possible fair testing scenario which he had posted on the interactive whiteboard. The scenario centred on a character called Alfie who was testing temperature conditions for plant growth by placing plants in different temperature setting; groups were asked to consider if the test was fair or not. Arun asked the groups to provide reasons and explanations for their ideas and come to a consensus. The ensuing talk is given in Transcription Box 6-21.
Nigel: it might affect it in the fridge it might be too cold it might freeze the seeds it will just go (boom) it will just go (ding) it needs to be
Lucy: it is a fair test
Nigel: even if it does pop out it is still frozen it will be the leaf will be frozen it will be a new species (using a different voice) do you like my ice cube stay there in the fridge for a few minutes
Beth: it is a fair test
Nigel: no it’s not
Beth: yes it is
Nigel: one is in the fridge and one isn’t that is not a fair test
Beth: no no ‘cos the experiment is if it can grow in the fridge
Oliver: if it can grow in another place cold (?America)
Lucy: it is a fair test because you are doing the same thing but putting it in different places so that would make it a fair test ‘cos like you are putting it in a cold place and then another plant in a hot place
The group are briefly distracted by a game of rock, paper, scissors at this point
Lucy: Alfie hasn’t got a nose on there
Nigel: oh yea
Lucy: so it would then it would then be a fair test because he’s putting equal he just needs to make the same amount of water doesn’t he
Oliver: or he could do it without putting water in
Lucy: they wouldn’t grow
Oliver: the fridge wouldn’t grow
Nigel: in the fridge if you open it it will start unfreezing so it will just go drip drip drip freeze what if the plant is like there and the drip is like there and it touches it drip drip drip and then it touches it yea and it’s not melting it is just so free it’s like (makes a noise) can we you get a beanstalk to go into space then jump from space and then go I think Alfie’s one in the fridge will grow because it will turn into a new species of plant it’s called the fridge plant
Lucy: no I think it will be the one on the windowsill because that is warm weather
Oliver: what
Beth: what what did you say
Oliver: what if we gave it hot water
Nigel: put it in the freezer
Beth: why would you put it in the freezer
Lucy: it will probably turn into an ice cube put it in your drink
Beth: it’s a funny experiment but it’s gonna be a good one
Lucy: sometimes when you are at a party
Nigel: when you drink it
Lucy: it's in the orange
Oliver: so which one will grow
Beth: no so get the same amount of water same cup same soil same amount
Oliver: but that water there goes up er what's the word Lucy for when its
Beth: transparent
Nigel: ah water vapour
Oliver: yes er yes that's it and er if you put it in the fridge

The groups are all stopped at this point to feedback to the class. Beth contributes on behalf of the group:

Beth: he will have the same amount of water and soil and the only thing that is different is the light

The talk begins with Nigel hypothesising about what may happen to the plant placed in a cold place. Lucy asserts her view that the test that Arun has shown them is fair and after Nigel continues with his parallel train of thinking, Beth’s repeat of Lucy’s idea acts as a confirmation. Nigel challenges this, following up with a justification. Nigel’s reasoning leads Beth to also supply a justification for her line of thinking and this is elaborated upon by Lucy. After a short time off task Lucy re-orientates the group by repeating her original idea, perhaps in an attempt to confirm this as a consensus and then she elaborates her thinking, extending the group’s line of discussion to begin to consider other possible variables. Oliver’s hypothetical idea to keep the water variable the same is challenged by Lucy and the group then spend some time making predictions about the plant growth in two environments, which is not the task which Arun set. After the group again stray off task briefly, Oliver moves to orientate the group with his question about a prediction but Beth challenges this with her repeat of the variables to be kept the same. Oliver seems to pick up on one of these variables, with his reference to water vapour, perhaps indicating that he believes this may make the test unfair although he does not state this explicitly. What is interesting is that when the group are asked to feedback, a completely new idea of light included. It is not possible to be certain if Beth was confusing her vocabulary or if the idea of light was something she was trying to explore in the group discussion when she repeats the range of variables towards the end. It seems that the group did not have enough time
to discuss fully, perhaps diverted by Nigel’s push to consider predictions on growth. However, despite the lack of consensus from the dialogue, features of productive talk are in evidence and the group generally follow a relevant line of thinking with a focus on the discussion of variables. The children do engage in a discussion which evaluates an inquiry process and their talk shows some exploratory features, therefore it can be concluded that this is more productive than the procedural talk which has been strongly in evidence to this point.

These data perhaps demonstrate that Arun was developing this thinking about how he wants children to learn and talk; ‘as a scientist, what would they do for a fair test so they’re sort of developing their investigative skills through talking’ Arun Oral Diary 8 and that as he worked on his practice of using group talk he began to consider a wider range of ideas about what it means to talk in scientific ways.

At the end of the study Arun once again espoused beliefs about the process of science being important for learning. The way he expressed his beliefs about science learning highlights a developing epistemology – that for him science is not just facts or using vocabulary in isolation and more about a way of thinking about the world. He demonstrated that his ideas about science learning now prioritise providing pupils with opportunities to work independently and to develop scientific ways of working and thinking. Through the consideration of how to best facilitate group discussion Arun appears to have constructed new ideas about the process of science learning:

That’s what scientists do and it’s a sophisticated this scientific thinking, and I think I’ve developed that a bit more this year rather than just concrete knowledge of what words mean or what they are.

Previously I may have wanted to get a worksheet done let’s just say we’ll find out all the facts and write them down. Now I’m more willing to let them have a free rein, let’s be less worried about the concrete knowledge. It’s the investigation process I want them to learn not necessarily that is the end product, it’s the process you want to teach not necessarily just the knowledge bit right at the end of it so it’s a process really that I’m trying to foster not the just end knowledge...I want questioning amongst themselves more, like bouncing ideas off each other rather than there being a concrete knowledge right or wrong.

It’s the investigation part, it’s the ideas you want to generate and thinking skills you want to generate in science so it’s not just the vocabulary in itself although
that’s important you do want them to use correct vocabulary in science... and
group talk is a good way of spreading vocabulary any good vocabulary.

Arun Final Interview 1

If the children come up with their own ideas for investigation that’s good
because that is how they will develop a curiosity for science and that’s what it is
about basically it’s the curiosity that you want them to develop oh I wonder
why that happens and in a group its non-threatening just allowing them to ask
what ever questions they want and that’s developing the inquisitiveness about
the natural world; it’s really a non-threatening environment to develop
scientific thinking.

It’s the thinking you are developing; it’s not just the concrete knowledge all the
time. It’s a process they are learning about so it’s those skills you are teaching
as well rather than just the concrete knowledge.

It’s not all about knowledge and facts it’s more about the scientific process and
thinking as a scientist. The best scientist would ask a question and think what is
the possibility of doing this and that’s the sort of skills I want them to do not
necessarily just the facts at the end of the process or they are just learning facts
and not developing as a scientist.

Arun Final Interview 2

What is interesting about these final comments from Arun is that they are quite
extensive and he describes a vision for how he wants to use talk in science, as a vehicle
to develop scientific thinking and a tool for focussing on the creative process of
science. However, in practice his beliefs about science learning being the reproduction
of knowledge and the correct use of terminology often constrained him from taking an
inquiry approach as a location for the peer group discussion tasks.

6.3.3.3. Simon

When Simon reflected upon the third lesson on shadow formation it was clear that he
had made planning decisions about how he could facilitate talk by drawing on an
inquiry approach to learning:

The intention for the talk specifically was to come up with their ideas and then
to see it through and test to see if those ideas work so that was the intention...It
was a get on and do, it was just a case of get together and talk, talking about it,
what’s happening and put that into words...that’s where they learnt when they
were giving it a go, getting your group to come up with a science experiment, I
think that worked strongest because they were hands on finding things out and
discussion is part of that, so it’s creating opportunities to take discussions there and I think that helped to move their learning on.

Combining different ideas and thinking how was that working and that was the other group talk that I thought worked well is when they actually had the materials and they were thinking about what to do, so the equipment thing, what they could do, the interactions there worked well. 

Simon Oral Diary 3

These comments again demonstrate an apparent focus on the procedure of the inquiry and how the children could talk their way through this although other comments during the reflection suggested that there was a specific element of the inquiry process where Simon felt talk was of particular benefit:

They had to work together to find out what to investigate...to decide as a group what they were talking about and to think about the question really...they were coming up with the questions, they had to play around with it and that level of inquiry was heightened I think. 

Simon Oral Diary 3

Simon appeared to have had a more specific emphasis for the group talk in this lesson, that he was using it as a setting for children to think of possibilities in order to create questions. This perhaps indicates a shift in thinking about the potential for group discussion activity in inquiry activities. An extract which exemplifies the productive group talk emerging when pupils came up with ideas for questions to investigate is included in the previous chapter (see Transcription Box 5-9, p.197).

During lesson four Simon introduced a problem solving type activity for groups to discuss which was based around the concept of refraction and the children were asked to work in groups and share their ideas about how to ‘bend a pencil’ when provided with a limited set of resources (string, cup, water, tape, pencil, books, scissors, paper).

In his reflection after the lesson, Simon said that he had planned it as ‘a challenge, a hook so to speak, trying to get them in’ Simon Oral Diary 4. This comment is perhaps an indicator that Simon was drawing on an inquiry based approach to learning to generate engagement in order to get children talking. As Simon set the groups off to the activity, he encouraged them to be interested in each other’s ideas, to try them out:

Simon tells the class that he wants to hear interesting discussions, which will create some good ideas for testing out; he says, ‘give things a go’. 

Simon Lesson Observation 4
The task held the potential for children to draw on their prior knowledge to consider
the situation and make suggestions and by utilising this approach Simon demonstrated
constructivist beliefs about learning. Children’s talk from this lesson does demonstrate
some interesting features with children making suggestions and providing
justifications (see Transcription Box 6-22).

Transcription Box 6-22

Tom: it’s a bizarre idea but I think it might just work right here’s my idea listen to
my idea
Mark: what will we do with the water
Evan: can I have your book a minute Ella can I see your book
Tom: yes that’s my point what we need to do is get a piece of string round it then
dangle it into water and see what happens that might do something because it’s
made of wood it might bend
Mark: Evan
Tom: I don’t know we just need to test it
Ella: it says there in the optical illusion book
Tom: get it out
Ella: I don’t know where it is
Tom: think about it because of the water it will look like it is bending dangle it in the
water something might happen
Ella: it might look like it’s bent but isn’t actually

A little later as the teacher passes by:

Ella: look it is bent
Tom: shush you are not supposed to tell him
Simon: my next question is then if you can think why does it appear bent
Evan: because of the light
Ella: probably because of where the water line is there
Tom: what do you mean
Ella: it looks like it’s
Tom: stare at that
Mark: stare at what
Ella: it might be because of the water line like in a swimming pool when you look down
in the water it changes everything
Evan: (indiscernible mumble)
Ella: it can bend it
Tom produces the optical illusion book and the discussion moves onto that
This extract begins with the children throwing in suggestions for group consideration, Tom with his idea for activity and Mark with a question about the resources they have been given. Tom was a continually dominant character in this particular group through the whole year and here his idea is accepted for testing almost immediately and without challenge, although he does attempt to provide the group with two separate justifications for it. Tom’s idea leads Ella to briefly hypothesise about the situation before any testing begins but no one in the group takes her idea up. A little later once the testing has taken place, Simon intervenes in the group with a question to challenge them further now that they have completed the practical part of the activity. This prompts Evan and Ella to make some suggestions and Tom’s request for clarification leads Ella to extend her contribution with a justification based upon previous experience. At this point Tom spots the optical illusion book which has been mentioned at the start of the extract and this interesting dialogue is cut short as the group begin to explore the pages. It seems that Simon’s use of a challenge to motivate the children and his intervention with a further question led them to engage, if only briefly, in productive and Exploratory Talk.

Simon’s reflection upon his planning for this session demonstrated some focus on the way in which children were working and talking:

*I planned it so that there was talking. I was trying to think of resources they can work with to come up with possibilities, with a way of investigating what they’ve been given and hoping that will facilitate the conversation. It was kind of almost less knowledge based more practical based but I think that helped with the conversation as well.*

*Simon Oral Diary 4*

The learning opportunity Simon provided invited children to think in a hypothetical way, to consider possibilities based in their prior experience and then test them. The emphasis on higher order operations is perhaps some evidence of a subtle shift in thinking about what Simon wants to achieve through the peer group discussion; that it is not just a vehicle for getting something done collaboratively but also for exchanging, considering and explaining ideas.
At the end of the study Simon demonstrated new beliefs about how talk could be beneficial for science learning. He talked at length and on numerous occasions about how he believed that practical activity could support group discussion, by setting pupils challenges which could be talked through:

_I feel it’s developed now into a place where yes I’ll, during science, set an activity for them to do and get them to come up with the way themselves, how they’re going to tackle it, which is great... the strength of it has been those group discussions when we’ve sent them away with a particular challenge... you’ve got engaged children with the task in hand, practical activity preferably, talking about what it is that they’re trying to solve or what it is that they’re trying to do._

If I give them something practical to be working with, that will enhance the discussion as well, so it allows them to not just be thinking about it, they can actually do it and then talk around it as well, so they could work round a problem, talking about it and doing it, I think it’s just about having something there and being able to talk about it, but there again I think that really helped them in terms of coming to any sort of conclusions or methods and I thought that was successful so there’s good practice.

_I’d want to include more practical discussion from this point forward anyhow, looking for those opportunities. You can’t have them in every science lesson, but you look for those options where you can include them and because the children have responded by saying they’ve got a lot more out of it, make sure it’s not just knowledge-based ... because if you go too much thought-wise or like in the head, some children just have no concept or find it really difficult to concentrate, so it helps really focus what the discussion is about and what is their talk about._

**SIMON FINAL INTERVIEW 1**

When asked how group talk was different to talk in other subject areas, Simon no longer mentioned vocabulary which had been such a focus for talk at the outset of the study; instead he drew on other aspects of science:

_In science there’s research opportunities because they can investigate... in science you are trying to get them to think of more of the why rather than just the fact side of things what’s happening and why... it differs in the content of the conversation._

**SIMON FINAL INTERVIEW 1**

What I’ve taken from this project is that inquiry activity and problem solving and trying to get more of that happening because this project is about talk and I think that’s where the quality of talk comes in.

**SIMON FINAL INTERVIEW 2**
What these data show is a new emphasis on the potential of talk to enable pupils to work through practical problems and inquiries that was not present at the outset of the study. This suggests that Simon’s beliefs about the role of talk appear to now focus on the processes of science learning rather than on polished products rich with technical vocabulary. This shift in thinking may have arisen due to the pupils’ responses to their use of talk in lessons as revealed in the focus group interviews and Simon made mention of these on two occasions:

*Problem solving and inquiry activity that is something I’ve enjoyed and I know the children have got a lot out of it when there’s been a challenge or a problem that they have to solve.*  
**SIMON FINAL INTERVIEW 2**

*I think one of the last ones when there was a lot of praise of the challenge side of things. I took a lot from that and thought do you know what, that’s really good to hear that, that’s what they like which made me think well actually that’s what we need to make sure we’re doing next time.*  
**SIMON FINAL INTERVIEW 1**

However what these comments also reveal is that Simon is perhaps considering pupil enjoyment as a determinant of the quality of discussions. Of course enjoyment is an important factor to take into account when planning learning opportunities but the cognitive power of peer group talk also requires consideration if the role of the teacher in the process of its facilitation is to be maximised (Alexander, 2008c). During reflections or informal and unrecorded discussions, Simon only once referred to the transcripts of group talk that he was provided with throughout the study. This reference was to feelings of disappointment with the off task talk he had seen in the transcripts of lesson two *‘I mean there was one where they were being a bit silly and stuff’* **SIMON FINAL INTERVIEW 1**. Even when prompted to reflect upon the transcripts Simon only discussed the focus group interview pupil comments and it could be that he did not have enough time to read the peer group talk transcripts, which were of course lengthy. However, the impact of that is that in discussing his pupils’ talk he was really only able to provide an impression of what was happening based upon his classroom observation rather than an informed analytical position based upon transcript data.
6.4. Conclusion

Scientific inquiry as a setting for classroom learning has the potential to facilitate productive dialogue (Varelas et al., 2008, Gillies, 2013) and the data presented show that inquiry based learning was a frequently used context for children’s dialogic activity by the teachers in this study. For all three teachers the initial focus for dialogue was on the collaborative procedure of practical investigation and this is in line with literature which suggests that the planning and conducting phases of inquiry are emphasised because they engage the pupils (Forbes, Biggers and Zangori, 2013, Ødegaard et al., 2014). However, encouraging children to work as scientists should go beyond hands-on activities and include the evaluation of evidence (Chinn and Malhotra, 2002) and children being engaged in an inquiry does not mean that they will automatically work in a scientifically inquiring way (Abd-El-Khalick and Lederman, 2000). Over time a shift to a more broad consideration of the inquiry process in the planning of group discussion tasks seemed to be evident through changes in ways of acting in the classroom and this led some productive, exploratory talk to emerge from the peer groups. However, the shift was not smoothly progressive or free of tension but the non-linearity of the process of developing thinking perhaps reflects a spontaneous and iterative process of sense making (Monrouxe, 2009).

The extracts of group talk presented through the authentic inquiry section of this chapter show that when the focus for talk was on specific features of inquiry the children were given opportunities to hypothesise, consider possibilities, challenge, justify, examine evidence and explain; to talk science (Lemke, 1990). The teachers’ shift toward a wider consideration of how inquiry learning may facilitate talk meant that pupils were given opportunities to engage in the epistemic practices of science and were therefore offered a more rich and meaningful learning experience (Lederman, 1992, Duschl, 2000). In summary, the three teachers mediated constructive, dialogic learning experiences through considering inquiry as a specific learning aim and having a focus on the process of learning rather basing practice on an elementary consideration of the collaborative role talk can play in practical activity. Table 6-5 summarises the participating teachers’ epistemological beliefs described in
those given in bold emerged during the project and therefore add to the original set (plain text) given first in Table 6-1.

Table 6-5: Overview of epistemological beliefs revealed during project

<table>
<thead>
<tr>
<th></th>
<th>Emma</th>
<th>Arun</th>
<th>Simon</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>About science</strong></td>
<td>Science is a body of knowledge</td>
<td>Science is a body of knowledge</td>
<td>Science is a body of knowledge</td>
</tr>
<tr>
<td></td>
<td>Science is practical</td>
<td>Science is a process of inquiry</td>
<td>Scientific inquiry confirms knowledge</td>
</tr>
<tr>
<td></td>
<td>Practical work is linked to knowing</td>
<td>Scientific understanding achieved through inquiry</td>
<td><strong>Science is collaborative</strong></td>
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<td></td>
<td>Science is collaborative</td>
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<tr>
<td></td>
<td><strong>Science is a process of inquiry</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>About science learning</strong></td>
<td>Group talk for planning and conducting practical work</td>
<td>Group talk for planning and conducting practical work</td>
<td>Group talk for presenting scientific knowledge</td>
</tr>
<tr>
<td>and how peer group talk</td>
<td></td>
<td></td>
<td><strong>Group talk for developing scientific knowledge through an exchange of ideas and experiences</strong></td>
</tr>
<tr>
<td>facilitates this</td>
<td>Group talk for developing scientific knowledge through an exchange of ideas and experiences</td>
<td>Group talk for developing scientific knowledge through an exchange of ideas and experiences</td>
<td><strong>Group talk for developing scientific knowledge through an exchange of ideas and experiences</strong></td>
</tr>
<tr>
<td></td>
<td><strong>Group talk for participating in higher level epistemic operations of scientific inquiry</strong></td>
<td><strong>Group talk for participating in science as a way of thinking</strong></td>
<td><strong>Group talk for participating in higher level epistemic operations of scientific inquiry</strong></td>
</tr>
</tbody>
</table>

The presentation of data shows that in considering peer group talk, teachers draw upon their beliefs about what science and science learning are. At times beliefs about science learning as being developing a body of knowledge dominated and at other times beliefs about science learning as being engaged in inquiry were the basis for planning for group talk; a tension between the two was evident (Golding, 2013, Bryan, 2003, Wallace and Kang, 2004). The presentation of the data analysis also demonstrates that over time, as teachers considered their use of peer group discussion, there was a shift in emphasis in espoused beliefs and sometimes also tacit beliefs towards ideas about how talk could enable pupils to act as scientists engaged in the exploratory process of inquiry. Through this shift, the process of learning through talk appears to have been reframed by the teachers (Pimentel and McNeill, 2013,
Harlen and Allende, 2009) – that it is not just for developing understanding of the products of science but also for engagement in the processes of scientific thinking.

The final analysis chapter which follows explores other tensions which suffuse the participants’ ways of thinking.
7. Tensions for Teachers using Peer Group Talk
7.1. Tensions and dilemmas

From the analysis of the interview data it was evident that tensions permeate through the teachers’ ways of thinking about peer group talk (Figure 4-2, page 148); challenges which they had to face when incorporating group discussion in science. Teachers referred to issues which perhaps caused them to feel that their ideal notion of practice in this area was under some kind of strain. Some of the tensions identified through the coding process have already been explored in the preceding chapters such as ideas about pupil ownership of learning leading to feelings of insecurity for teachers and the perennial constraining factor of time. In order to develop the picture more broadly and demonstrate the range of challenges faced by the participating teachers in the use of peer group talk, in this chapter I will explore other categories in this theme. These categories are, balancing social and cognitive aspects of talk, accountability, pupil resistance and gaining conceptual consensus.

7.1.1. Balancing social and cognitive aspects of talk

Some of the discussions which teachers facilitated enabled children to develop new ways of thinking about scientific concepts. For example, Appendix 9.6a p.360 contains an analysis of transcript data which reveals how when required to hypothesise about the processes of physical situations, pupils used talk productively to develop their ideas about concepts. In addition, detailed discourse analysis (Appendix 9.6b p.364) reveals how learning was facilitated by enabling pupils to co-construct and maintain a shared framework of meaning (an IDZ) as a reference tool in their dialogue. Setting up this IDZ (Mercer, 2000) acted as a scaffolding mechanism, helping the teacher mediate the learning journey and introduce systematic ways of thinking about concepts. This allowed children, as they worked independently in groups, to talk in exploratory ways; to structure and modify their thinking and take their ideas further than they would possibly have been able to do alone. This demonstrates the cognitive benefits of group talk, however this aspect was not always the focus or intention of the participating teachers’ thinking (Appendix 9.6b p.364) and perhaps the learning occurring within the IDZs, made visible through the transcriptions was serendipitous. Indeed, throughout the study, the teachers often demonstrated rather less ambitious ideas about the
purpose of talk which perhaps highlights the importance of developing awareness around how talk can be an effective way to help children develop scientific understanding, even with teachers who are enthusiastic about working dialogically (Mercer, Dawes and Kleine Staarman, 2009). When asked during the interviews what productive group talk should look like, Emma focussed on social elements such as engagement, confidence and participation:

...to believe in themselves and have the confidence to say well I think this, that’s the biggest challenge to get them to speak out and give their reasons.  
**EMMA INITIAL INTERVIEW 1**

What does productive talk look like, it’s children being engaged and on task and having something to say and being brave enough to say it... they are learning from each other and they feel safe with each other... It’s a bit of PSHE thing as well isn’t it, not just a science thing.  
**EMMA FINAL INTERVIEW 1**

A focus on engagement as a particular purpose for group talk could perhaps also be detected through observations. Emma sometimes dropped into lessons short episodes of group discussion which were not initially planned, usually at points where she had been taking the floor for a while. When speaking about productive talk, Simon immediately focussed on children being engaged and involved, perhaps suggesting that he too was primarily concerned with the social aspects of group discussion rather than cognitive:

...where the children are all engaged, they’re all on task, they’re all having a go and they’re all thinking about what it is they’re doing, they’re just doing it...what it looks like I feel is where you’ve got engaged children with the task in hand, practical activity preferably, talking about what it is that they’re trying to solve or what it is that they’re trying to do and I think they get a lot from that in terms of confidence and satisfaction.  
**SIMON FINAL INTERVIEW 1**

Social and affective factors also had a high value for Arun who appeared to think of talk as a tool for peer support and confidence building.

They can support each other in the talk so that if you have some children who are very reluctant to talk it is a support mechanism for them in that you are not pointing at them directly and saying what are the answers to this, so they can have a discussion about it and for those children who find it difficult to generate ideas it would help them... because I want them to be more interactive, engaged in the lesson and it just gives them more confidence to actually talk to each other.  
**ARUN INITIAL INTERVIEW 1**
He mentioned the fact that a small group discussion was a less threatening space than the whole class and this meant that pupils developed confidence; ‘*they’re also learning the whole co-operative skills and working with that, so it’s good for PSHE as well*’ and ‘*I’ve used pair share ideas a lot because it just allows them to talk without feeling threatened about what they need to say.*’

Arun also felt that a critical challenge was the creation of groups that worked collaboratively together and during many of the observed lessons, Arun utilised very structured group talk management strategies such as giving roles to each person in the group and at other times he used a ‘talk shape’ to manage turn taking. These kinds of strategies were an attempt by Arun to facilitate harmonious collaboration and discussion, and ensure children had clear understandings of the workings of a group. However, they often led to bickering and disquiet as children focussed on how the management tool was working for them, rather than discussing the content of the lesson. By trying to control the talk with these kinds of strategies Arun appeared to create difficulties for himself and in having too much structured talk, group management became the central issue and ideas were led away from science (Keogh and Naylor, 2007). Observing how he changed strategies around and finally seemed to cast them aside perhaps showed that he was facing a dilemma in how to balance effective group discussion and collaborative structuring (Cohen, 1994).

The preoccupation with social and cooperative aspects of group talk, rather than cognitive (see Appendix 9.6b p.364 for three detailed examples) could be viewed as a tension for Emma, Arun and Simon in that it has potential to lead them to experience challenge in exploiting dialogic approaches for the development of children’s understanding. Although the social aspects of group talk are important factors, there is perhaps a question to be raised about the level of emphasis. Alexander (2008c) suggests that the focus placed by teachers on social and affective purposes of talk may mean that they do not fully acknowledge and therefore exploit its importance for building powers of thinking. When the teachers did discuss cognitive aspects of group talk, it was often framed in terms of children simply sharing ideas:

*They are learning if they are sharing information, because they might share something with someone that they didn’t know before so then they go ‘oh*
right’ and there’s the learning going on when they are sharing in a group... that’s easy and they are always happy to talk about what they know and what they’ve done.  

EMMA INITIAL INTERVIEW 2

I think it is important to work together as a group and that they have a chance to show off what they have got...it’s about sharing opinions, how they have come to their decisions and why they have those opinions...what I think is important is being able to express their opinions and being able to share with reasons why they have those opinions.  

SIMON INITIAL INTERVIEW 2

It’s actually about generating ideas, sharing ideas. It doesn’t matter if you copy; it’s more about becoming confident and gaining more knowledge and gaining more ideas.  

ARUN FINAL INTERVIEW 1

I think at the minute where I’m at is the information sharing basically it’s, what they’ve found out and how they’ve got there, but no deeper than that at the minute.  

SIMON FINAL INTERVIEW 2

Although sharing ideas is certainly an important and useful function of peer group talk, framing it only as a place for children to transmit ideas to one another is considered a simplistic approach to thinking about how dialogue can influence individual thinking (Littleton and Mercer, 2013). I also noticed a pupil focus on sharing of ideas during focus group interviews:

When I listen to the children speak in their interview, they often talk about sharing ideas but rarely about questioning or challenging.  

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The types of comments to which I was referring to in this reflection are exemplified below:

Lucy: It helped me find out new things  

ARUN PUPIL FG INTERVIEW 8

Ella: It was kind of like we sort of learned things from other people  

SIMON PUPIL FG INTERVIEW 4

Beth: Because other people that know said stuff you could hear them say it and then you knew how to do it more  

ARUN PUPIL FG INTERVIEW 1

Ali: It helped me and other people around if somebody told you something and you didn’t know it you can be like oh I know that now and pick it up from other people  

EMMA PUPIL FG INTERVIEW 4

Oliver: When you talk you get to share ideas and if you don’t know something and somebody does you can tell the other people your idea what it is  

ARUN PUPIL FG INTERVIEW 7
These particular comments, of which there were many more to choose from in the data set, demonstrate a limited understanding of the cognitive benefits of peer group talk which could impact upon pupil success in collaborative learning (see Appendix 9.6b Bones p.364 for an example to the contrary). Children’s ideas parallel those of their teachers (Fisher and Larkin, 2008, Kershner et al, 2014) in that there is a focus on how talk is about sharing ideas and therefore, perhaps teacher beliefs have had an impact upon pupil perspectives (Mansour, 2009, Fang, 1996).

7.1.2. Pupil resistance

Not surprisingly, at points during the study and in all of the settings, there were times when pupils were not fully on task during group discussions, preferring to talk about birthday parties or playground antics. In addition, the focus group in Arun’s class displayed an erratic ability to engage in harmonious dialogue and a particular pupil in Simon’s class had a tendency to dominate and sometimes disrupt, yet was also a key group member who drove collective ideas forward with his questions and reasoning. Balancing out creativity and thinking productively with disruption can lead to tensions for teachers and behavioural issues can create feelings of vulnerability (Osborne, 1997). One of the children in Simon’s class pointed out the temptation to move off task when working in groups:

_Ella: I think Tom was quite helpful when we were talking, he kind of like directed us and if I had been with my friends I wouldn’t have been directed I would have been silly_  

SIMON PUPIL FG INTERVIEW 3

In discussing her thinking about facilitating productive group talk in her classroom, Emma referred heavily to the importance of ensuring the social environment was conducive to collaborative work, in particular because there were pupils who were not attentive or did not remain engaged with others’ ideas and contributions. Emma also concerned herself with issues around pupil attitudes to group talk and found that at times she felt these created resistance because pupils may hold preconceived ideas about how well peers would be able to contribute to a discussion in science:

_You have to be aware of the other children’s’ attitudes in the classroom that they think oh you don’t know anything because you can’t, your writing’s like_
Simon felt that perhaps there were times when children were not keen on talking too much, because in sharing ideas with others, good ones could be stolen. In fact one of his pupils mentioned this too, Ella: ‘I didn’t like that I said the ideas out and everyone copied me’ SIMON PUPIL FG INTERVIEW 4. Taking an opposite thought however, one of Emma’s pupils Sam, proudly stated ‘perhaps the rest might do a chart now’ EMMA PUPIL FG INTERVIEW 3, clearly showing he did not have the same concern about sharing his ideas. It is interesting to note that it was Simon who was concerned about his pupils’ lack of awareness of how talk could develop their learning and perhaps this example of resistance is evidence for Simon’s conclusion and that Ella’s thinking about talk stems from a weak understanding of how it can be beneficial.

Arun had concerns that pupils may feel that they couldn’t openly share their ideas because of a need to get the right answers:

I’m conscious of the fact that they are worried about what the teacher thinks and they are worried that actually there’ll be a right and wrong answer about it. ARUN FINAL INTERVIEW 1

Emma also noted this: ‘sometimes they’re just a bit more wary of saying what they want to say’ EMMA FINAL INTERVIEW 1 but she suggested that this resistance may come from pupils not wanting to think in depth.

Pupils’ own ideas about how they learned best in the range of observed lessons were mixed. Towards the beginning of the project, Simon’s children saw the teacher led parts of the lessons as where they learned the most:

Mark: when he was standing in front of the class SIMON PUPIL FG INTERVIEW 1

Ella: when Mr Y was teaching us on the carpet...yea at the start when we were getting shown what we were doing on the carpet, because he was erm showing us stuff’ SIMON PUPIL FG INTERVIEW 3

At this point, perhaps the children had not yet understood the importance of talk because it wasn’t the dominant format of learning and in fact this was the concern
made explicit by Simon and pointed to earlier, that his pupils may not realise the full potential of talk.

In Emma’s class, this idea was also suggested in different ways - that because the teacher was not in the group, there was no one there to support or that there was a sense of frustration that the teacher was expecting the children to do the work:

*Harry: I’m not sure who helped me because we were talking together and when we were talking together er basically I didn’t really know everything but erm no one helped me with my work no one said oh Harry you did something wrong here.*  
*EMMA PUPIL FG INTERVIEW 4*

*Ali: I didn’t like that we had to explain Mrs Z could just tell us and if we get it wrong she can tell us again. So it’s like (today) you have to try and like know what you have to pause she can tell us what is wrong and right tell us a bit about what we have to do and explain a bit about it and then we can get on with the work and she chooses if it’s right or wrong*  
*EMMA PUPIL FG INTERVIEW 4*

These examples show that despite children having successful discussions, at times they apparently feel more comfortable viewing learning as being transmitted to them from their teacher. Pupils hold epistemological views about the teacher as ultimate validator of knowledge as truth (Pratt, 2006) and these may become a constraint for their beliefs about taking ownership of learning through group discussion.

The idea of learning mostly from the teacher, despite all the group talk activity arose in Arun’s class too. In fact after a successful session on translucency (see Appendix 9.6b Extract 11 p.378) when asked how talking had helped them, one of the pupils, Nigel responded *‘To learn about new things because Mr X taught us’*  
*ARUN PUPIL FG INTERVIEW 3.* In a different lesson, where pupils were challenged to plan and carry out an investigation and think about absorbency of different materials, again there were hints of resistance from Beth, when she said she didn’t like the *‘talking with these two. I wish we could, Mr X could just tell us’*  
*ARUN PUPIL FG INTERVIEW 6.* Her ideas were clarified by her peer:

*Oliver: Beth means you know how we go all through all the talking about absorbing and stuff that’s what she means she don’t like that bit but she just wants Mr X to tell us what to do.*  
*ARUN PUPIL FG INTERVIEW 6*
This emerged a good way through the project where Arun was beginning to give more control over to the children and let group talk activity do more work. It was apparent from the transcriptions of group talk, that Beth was struggling to grasp the concept of absorbency so perhaps the challenging activity, led her to want to revert to an inactive position of being directed; perhaps having more control over where her learning was going, was in fact uncomfortable for her. Later in the interview when the children were discussing which part of the lesson they learned best in, Beth actually perhaps began to realise that the group talk had enabled her:

Beth: I didn’t quite get it when we was talking then I realised more about it when we doing the experiment I learned a bit of it but I didn’t get it all and then when we did the experiment I figured out more what it meant

Nigel: see

Oliver: so talking together Beth did help you find out half what absorbency was

Beth: not half not even half

Despite the hint of resistance, a little later, Beth even began to suggest that talking with the other two in the group was helpful because she had been able to ask questions - ‘I asked the questions and they answered them for me’ Arun Pupil FG Interview 6. This actually suggests a more sophisticated understanding of how talk is utilised to develop understanding, that she was able to articulate her uncertainties as questions, showing a clear idea of where she hoped to develop her thinking.

One of Emma’s pupils expressed that she felt unable to get involved in group discussions - Yvonne: ‘I don’t really enjoy it. I just usually really just listen and they don’t really let me do something’ and that she preferred teacher led work because ‘well everyone can hear her’ Emma Pupil FG Interview 2. A pupil in Arun’s class also voiced resistant feelings about group talk because she felt other pupils dominated her and after one lesson the group spoke explicitly about the issue:

Beth: I thought something different and I was trying to say something different but

Lucy: but it was a bit unfair

Beth: yea
In this lesson, Arun had tried to get the pupils to question each other and come up with a consensus about their ideas about transparency. From the transcriptions of pupil talk (Appendix 9.6b Extract 11 p.378) it was clear that it was a successful strategy because there were a good number of features of Exploratory Talk in evidence. However, the discussion also appeared to have put Beth under some feelings of strain because her ideas weren’t validated through the group. A different pupil in Arun’s class had similar feelings of discomfort at a later point in the study when his personal conceptions were challenged by the group:

Oliver: when we were sorting it out and people were saying sausages aren’t good for you. I like sausages and these three said sausages are not good for you but I still haven’t changed my mind, they are still lovely.

During the lesson, Arun first asked children to discuss what they thought the word diet meant. Following this they were given a set of different foods to sort into groups of their own choosing and Arun hoped to hear specific types of talk from the groups:

To get them to ask the questions themselves; to get the chance to talk; I just wanted them to use correct vocabulary; I thought they could give the reasoning.

The focus group decided to sort foods into ‘healthy’ and ‘unhealthy’ before moving on to discuss the range of food items. An extract of their talk is given in Transcription Box 7-1.

Transcription Box 7-1

Beth: I like sausage
Nigel: okay but it’s unhealthy
Beth: yea I like the sausage
Nigel: okay this is healthy this is healthy
Oliver: you know about fish
Beth: this is healthy healthy
Teacher Assistant: be sensible please right one at a time
Beth: actually they are healthy miss they are healthy because they are potatoes
Oliver: yea but they no they put loads of sugar in them
Lucy: crisps  a healthy snack
Oliver: no they are fried
Lucy: fried
Lucy: they are fried and then you put salt on them
Beth: what comes from the ground but you don’t dig it up
Lucy: would meat be healthy or unhealthy
Oliver: er healthy
Lucy: well meat is strong but I don’t actually know if erm
Oliver: it’s natural

The group move to consider bananas before Oliver brings attention back to sausage:

Oliver: this is healthy
Beth: you are eating an animal man
Oliver: I say sausages are healthy
Beth: urgh
Nigel: unhealthy
Oliver: healthy I think healthy
Beth: I think unhealthy
Oliver: healthy though because they are natural they are really
Nigel: but they are unhealthy
Oliver: but it only has to be shaped that’s that
Nigel: yea arh what about potatoes  where are they
Oliver: they use to fill it  they used to use intestines of pigs
Lucy: would cheese be healthy

At this point the group placed sausage in the unhealthy group and the discussion moved away to consider cheese and pasta:

Lucy: my mum cooks pasta I think it can be healthy
Nigel: who has eaten stilton before
Oliver: it’s all mouldy every single piece of cheese is mouldy
Beth: pasta is healthy
Nigel: who has eaten stilton before
Lucy: not me
Nigel: I spread it on my (unclear) one time  once I ate a big bit
Oliver: Beth put it back on there
Beth: all I was doing was looking at it I wasn’t going to put it on
Oliver: stop messing around
In contrast to the initial part of the extract where the group, with Oliver’s prompts, justifications and elaborations, sustained a line of thinking, the group did not come to a consensus on the cheese and pasta and did not offer any reasoned ideas, offering instead personal preferences and anecdotes. As the group discussion descended into a brief argument, the teacher stopped the class to take feedback. When viewed alongside the comments from Oliver in the post lesson interview, it could be interpreted that his contributions changed when his ideas were threatened and this altered the quality of discussion. Although, questioning and conflict were important features of the talk Arun was encouraging children to use, embracing the ‘creative potential’ of the tension between challenge and argument (Osborne, 1997), consequent feelings of insecurity for pupils also have the potential to divide and destroy a possibly fragile learning environment.

7.1.3. Accountability

During the final interview Emma shared how she now saw group talk as a vital part of her classroom culture because she had experienced how it had really worked with her pupils, engaging them and enabling them to learn from each other and not be so reliant upon the teacher. However, it became clear that her developing confidence and use of it over the year had generated a dilemma for her; on the one hand appreciating how powerful it could be for her pupils’ learning and how they valued using it in their science but on the other, feeling the need for written evidence. Despite all the working on understanding having been done through the talk, there was still a strong pull to collect tangible evidence from pupils and that classroom talk alone was not sufficient:

_I feel confident about doing it, full stop, because now I know I can, I’ve fine-tuned how I can get the evidence down as well, because the danger is you let them talk but then you’ve got no evidence and you’ve got to have something to show for the work that they do and to show people that you are actually doing something. You can get away with photographs and things like that, but with reasoning, I mean you can’t explain a child’s reasoning without them actually putting something down on paper in some way, so but now I’m getting better at that, kind of how to get the evidence from them...so I’ve become a lot more confident._

EMMA FINAL INTERVIEW 1
Indeed it seems from her words that there is risk in using too much talk because there is then no evidence for others to see. The language used by Emma suggests that she may feel that because there is no hard evidence, using group talk is something vaguely wayward, something to be got away with and perhaps Emma’s true confidence with this approach couldn’t emerge until she was able to develop and fine tune her ways of collecting this evidence and it was only then that she had developed ‘the full, the big picture, the full package’ Emma Final Interview 1. Concerns over getting something in books also surfaced during the project too as Emma reflected after one lesson:

_I think perhaps that I would have got them at a table and recorded things a bit more._

Emma Oral Diary 6

One of the ways in which Emma had used group talk was by encouraging children to ask their own questions for inquiry, by giving them the opportunity to lead their own learning, to take responsibility and to feel more in charge of it. However, she acknowledged that this also required her to have more confidence and courage because embedded within this letting go strategy seems to be concerns over accountability and responsibility. Conflicting notions of power present an enduring paradox (Wallace and Louden, 2002); the dilemma of on the one hand knowing that in allowing more freedom the children will be provided with valuable learning experiences which are based upon their own ideas, rather than those imposed upon them by the teacher yet on the other hand, feeling the need to control the learning in order to tick boxes, to cover herself and to be able to say she has taught the correct things, because it is she who will be held directly responsible for the children’s learning:

_Through that discussion then they’re coming up with questions, so they’re leading their own learning and then they feel more like they’re in charge of it ... and it might still be valid learning and valid experiences but at the end of the day as a teacher you’ve got to say I’ve taught them this...you’ve got to still tick those boxes haven’t you?_ Emma Final Interview 1

Perhaps this is an example of the impossible tension for teachers who are encouraged to innovate and foster creative ways to develop thinking with children yet are faced with accountability and audit culture issues (Craft and Jeffrey, 2008), creating feelings
of insecurity in utilising what they know to be good practice. Cultural beliefs permeating school science such as the need to prepare for assessments, can be internalised by teachers and then mediate the implementation of innovative practice (Wallace and Kang, 2004). Emma talked about how after initial exuberance with the strategy of using group talk, she had learned to find a balance with its use so that she then tried to get an element of it in every lesson in order that there was still time for written work. However, she did also point out that this recording was now more finely tuned ‘more focused I think because the work’s gone into the group talk in the first place’ EMMA FINAL INTERVIEW 1.

As has been previously described in Chapter 5, throughout the project Simon developed his practice to draw on more opportunities for groups to talk and work independently, without involvement from the teacher. He made reference to the fact that group talk can be a really important tool for learning; however his conclusion about allowing children time to talk by themselves has a caveat over requiring outcomes:

You start thinking actually there’s potential there for them to go forward with their learning a lot more...trying to give them that little bit more trust, a little bit more independence but equally knowing I still need to have an outcome, do you know what I mean? SIMON FINAL INTERVIEW 1

There were also acknowledgements from Simon, of the notion that for him more successful group discussion episodes were accompanied by some kind of recording or practical task:

It was a group discussion but it was recording it...it really helps focus what the discussions is about, if you go too much thought–wise or like in the head, some children find it really difficult to concentrate’; I’d want to include more practical discussion from this point forward anyhow. SIMON FINAL INTERVIEW 1

Perhaps this is evidence of Simon having not yet developed a deep trust in the power of talk to engage and develop learning; perhaps there was some insecurity, a feeling that talk is just not enough and this created tensions for him with the application of group discussion tasks, giving talk a supporting rather than a leading role in this classroom, or perhaps Simon feels the need to have a record of all of the science
activity for the sake of accountability. He did explicitly refer to feeling the pull towards needing proof when he is using group talk, to get something recorded.

*I think it has to be more than just a discussion, I think it has to be something recorded, not just to prove they’ve got anything out of it but just to ensure they’re on task.*

SIMON FINAL INTERVIEW 2

However, he also suggests that writing helps the children come to some sort of consensus:

*I think it helps to have things recorded, just so then it’s almost agreed upon...for example they’re able to just talk about it and say right then, have you come to an agreement and I think that’s quite important as well, but I will certainly say it’s as important as the actual activities themselves.*

SIMON FINAL INTERVIEW 2

In most of the observed lessons Simon planned for formal and individual written recording of the outcomes of science learning, despite his mention of school development sessions in which staff had been encouraged to move away from recording everything in books for science. Simon talked about this new idea in really positive ways and that it ‘is great, which gives me a little bit more freedom and makes, sounds a bit more enjoyable’ SIMON FINAL INTERVIEW 2. However, it seemed that although he had been given license by school management to not always require written outcomes from pupils, he still felt he must; perhaps feeling the tension of accountability or perhaps not knowing quite how to evidence the use of talk at this point because writing is generally the dominant format for communication in classrooms (Alexander, 2008c, Wallace and Louden, 2002). He describes it as trying to work with a ‘fine line’ between letting the children have time to talk through their work and yet when he looks ‘at the evidence it would be very limited’ SIMON ORAL DIARY 4. Simon’s ongoing use of recording for group talk may have had an impact upon pupils’ thinking (Fisher and Larkin, 2008, Mansour, 2009, Fang, 1996), so that children may have felt that their ideas are considered valid only through the medium of writing. In fact there are times when this is in evidence. When asked about how talk helped with the learning, Andrew suggested it was useful ‘to get your ideas down’ SIMON PUPIL FG INTERVIEW 5 and Ella commented ‘because it meant everyone got to put their ideas down and we all got to see the ideas’ SIMON PUPIL FG INTERVIEW 4. Perhaps
an emphasis on collecting evidence, on doing and seeing writing may lead to beliefs that talk itself cannot create a viable product and Simon also expressed this concern, when referring to how children value discussion ‘I think they may not realise the full potential of it’ Simon Final Interview 1.

7.1.4. Gaining conceptual consensus

Emma suggested that there were times when she felt that the use of group discussion was awkward; that in allowing freedom for discussion, misconceptions would be highlighted and reinforced. This dilemma can arise when teachers want to ensure learner participation but also aim to develop particular conceptual understandings (Brodie, 2010, Kim and Tan, 2011, Edwards and Mercer, 1987) and ideas generated through the group talk may not lead where the teacher wants them to go. Emma referred to a ‘bad experience’ when this happened with the use of Concept Cartoons and that she had subsequently shied away from using them:

…it gets them to talk about it, but I need to develop that a bit more because the couple of times I did it, it kind of just highlighted the things they didn’t know and then they re-affirmed the things they didn’t know rather and made each other have some misconceptions as well rather than iron out the misconceptions, so I think I used it at the wrong time in the lesson ...so rather than in the sequence of lessons I used that at the start rather than I think maybe I should have used it further in once they’ve had some learning, I don’t know, but that’s one of the things I want to sort of play around with and see where to use them to have better effect. Emma Final Interview 1

It is clear that for Emma, this dilemma led to her considering the possibility of altering the placement of open ended group talk designed to elicit children’s ideas to later in the teaching sequence. Although the idea of playing around with a teaching approach shows creativity and confidence, there is also a hint here of some tacit pedagogic discomfort. Rather than considering how she may work with the children’s emerging thinking and how intervention may challenge emerging misconceptions, Emma perhaps displays some insecurity and retreats, considering the swing to a more teacher led approach, and allowing the children to ‘have’ some learning. Perhaps
experiencing this dilemma caused a realignment of pedagogic stance from the ideal of a constructivist one to that which is more controlled and transmissive (Golding, 2013). Arun also talked about group talk as being a space where he could access children’s misconceptions:

> It’s just generation of the children’s ideas to find out their prior learning misconceptions and then they can talk freely in that non-threatening environment with other children and there’s no right or wrong at that stage.  

**Arun Final Interview 2**

Arun contrasted this open and free discussion of ideas, which was observed on a number of occasions during the project, with the need for children to ‘find the correct information to gain the knowledge’ **Arun Final Interview 2** which he suggested required a different approach. Perhaps Arun is tacitly showing that he is unsure how an independent discussion is a relevant forum for the enculturation of children to accepted knowledge patterns of science (Wells, 1999); that it is simply a space for airing and sharing initial thinking and that conceptual development requires the application of a different approach. There is a deep and enduring tension between pupils’ own everyday knowledge and the formal knowledge of science (Wallace and Louden, 2002) and perhaps Arun’s desire for authority and certainty of scientific knowledge unbalanced his recognition of student centred approaches (Kim and Tan, 2011). Scott, Mortimer and Aguiar (2006, p.623) suggest that if a science teacher views their role as ‘providing a robust and accurate account of the scientific perspective’, then there is no reason why they should draw on dialogic approaches in their classroom. They refer to the importance of shifting between dialogic and authoritative discourse and characterise it as a necessary tension in the science classroom, a fundamental and inevitable part of teaching and suggest that teachers move between dialogic approaches, which are useful for opening up pupils’ ideas, motivating and engaging students and authoritative approaches which provide opportunities for pupils to make connections between their own everyday ideas and scientific ones. These two ways of working in the classroom are at each end of a continuum and a tensioned and dialectic relationship exists between them as dialogic exploration of ideas requires resolution through authoritative guidance by teacher and also
authoritative statements require dialogic exploration by pupils. However, the excerpts from Arun above seem to show that he sees the two approaches as separate, not linked and observations in the classroom often seem to support this with lessons often characterised by a series of discrete talking activities punctuated by teacher input. Perhaps here, a lack of tension between approaches is what creates the challenge for Arun with the use of peer group talk.

Emma also refers to this tension when she talks about drawing pupils’ ideas together at the end of sessions:

*That’s the one I find I always have, not always but have difficulty with but it’s like bringing it all together at the end and still giving them a chance to say what they think, but also coming up with a final answer so that they leave all knowing the fact, the facts that you want them to know, so take all of their experiences and then, and then bring it all back to all of us agreeing on, not an answer but a conclusion, whether it might be different, it’s bringing it all back together again, I think once you’ve let go and you’ve done all those things, the consolidation bit is the hardest part like to make sure that we’re all together and leaving with the same ideas.*

Her strategies for enabling group talk mean that children initially have a chance to be individuals, drawing on their experiences and saying what their scientific ideas are but then this has potential to create a confusing mixture of contributions and responses causing real difficulties for this teacher who views part of her role as ensuring all of the children know all of the correct facts by the end of the lesson. Although these ideas could be teased out in dialogic ways, this excerpt shows that there is clearly a temptation to revert to a transmissive pedagogy in trying to achieve this and in fact during the final interview this possibility becomes explicit as Emma says that in her science teaching sometimes she does ‘*expect them to sit down and do...rather than learn, like to get out there and experience things’* 

**EMMA FINAL INTERVIEW 1.**

### 7.2. Conclusion

In drawing on the pedagogy of dialogic co-construction in their classrooms, teachers and indeed pupils, seem to experience potentially unresolvable complexity and ambiguity. Dilemmas and tensions constitute a viable way of considering the everyday practices of teachers and schooling in general (Fransson and Grannäs, 2013), are
deeply situated in a particular context and are experienced and managed individually by each teacher (Brodie, 2010). The tensions evidenced in the data presented appear to be interrelated. For example, notions of accountability and a product oriented culture perhaps lead to lack of trust and feelings of insecurity with interactive and dialogic approaches. In addition, the complex collection of thinking which emerges as children discuss their ideas independently can lead the teacher to have feelings of uncertainty with how to ensure the correct scientific knowledge is understood. These kinds of tensions in turn perhaps lead to a desire to constrain, control or direct children in ways which are apparently at odds with epistemological ideals formulated by the teacher regarding the use of talk. Furthermore, teachers having less than ambitious aims for peer group talk and not exploiting its cognitive potential perhaps influences pupils’ own ways of thinking about talk and their metacognitive awareness of how it may be used for learning.

Social constructivist positions hold that knowledge is created not received; that learning is socially mediated through collaborative activity and discourse. This approach is underpinned by the idea that pupils are active creators of their own understanding, that they take responsibility and build meaning for themselves as individuals. Discourse with others gives them access to alternative ways of thinking; the individual needs the group in order to develop their own ideas, yet the group needs the individuals to articulate and share their thinking. However, when teachers feel tensions and experience dilemmas, uncertainty and insecurity can surface and this can lead to an emerging gap between a teacher’s theory and classroom practice; a crack in their constructivist pedagogy (Orland-Barak, 2003).
8. Conclusion
8.1. Introduction

In this chapter I firstly review the rationale for the study and follow with a focus on the main findings. I then summarise how this study provides a contribution to knowledge not only in the field of teacher thinking about peer group talk in primary science classrooms but also methodologically. This second theme is considered through a reflection upon the iterative nature of the data collection and the employment of an oral diary. Finally I present the implications of the study and consider its limitations.

8.2. Establishing the research questions

The wealth of research centred upon the implementation of dialogic pedagogy in classrooms is testament to the important role language and interaction has in the development of pupils’ thinking. Peer group discussion is seen to be a dynamic and creative context for science learning (Baines, Blatchford and Chowne, 2007, Howe et al, 2000, Howe and Tolmie, 2003, Murphy and Beggs, 2005, Thurston, 2010) and based upon constructivist principles it holds the potential for meaningful interactions through which new understandings are socially mediated (Vygotsky, 1986). When employing group discussion the teacher’s role is wide ranging and enthusiasm for the approach is well documented (Bennett et al, 2010). However, there is also a catalogue of constraints with its application in practice, particularly in science where the perceived importance of pupils simply collecting correct scientific facts can lead to a prevalence of teacher led discussion and dilemmas with the incorporation of a pedagogic technique which promotes independence (Driver, Newton and Osborne, 2000, Lemke, 1990, Michaels, O'Connor and Resnick, 2008, Pimentel and McNeill, 2013). Indeed, research shows that the peer group forum is underexploited, with productive talk rarely occurring (Littleton and Mercer, 2013, Mercer and Howe, 2012). Calls have been made for the exploration of the routine, dialogic practice of teachers in order to understand more clearly how talk thrives and also the challenges faced (Howe, 2014, Reznitskaya et al, 2009, Wolfe and Alexander, 2008). Based upon this rationale, the development of situated understandings of the use of peer group talk in primary science was the overall aim for this study.
Teacher thinking has reciprocity with practice with beliefs shaping classroom action (Lederman, 1999, Tsai, 2002, Van Driel, Berry and Meirink, 2014, Wallace and Kang, 2004). Epistemological beliefs can influence perceptions about the value and role of peer group dialogue in science and also create tension and contradictions for practice (Kim and Tan, 2011, Mansour, 2013, Wallace and Priestley, 2011). Exploring teachers’ implicit and explicit considerations about how they create and interpret opportunities for talk is therefore important in trying to understand the complexity of classroom action, yet primary teachers’ beliefs about talk in science are not widely documented in the literature. In addition to this, despite long standing acknowledgements about the importance of incorporating pupils’ views in research, their ideas about talk in science are not often heard (Niemi et al, 2015, Rop, 2003). Gaining new understandings of teacher and pupil thinking about how peer group discussion in primary science occurs and developing further appreciation of the tensions inherent in this approach therefore can inform the literature around the routine use of peer talk. The descriptions of classroom action and the thinking associated with it may be interesting to practitioners, both experienced and trainee and could also be transferable to other classroom contexts. With all of these points in mind, I formulated a research question for my project:

*How and through what processes do primary school teachers engage pupils in productive group talk in science?*

Supporting questions were also articulated:

*What are teachers’ considerations regarding group talk in science?*
*What are teachers’ considerations when the talk is most/least successful?*
*What are pupils’ considerations regarding group talk in science?*
*In what ways does teacher thinking impact upon the practice of using group discussion?*
*How does teachers’ thinking about the use of group discussion change over time?*

### 8.3. Response to the research questions – main findings

The pupil group talk data provide some initial insight in response to the overall research question. In line with existing literature, productive talk was not strongly in
evidence across the observed lessons (Appendix 9.3 p.344) and this perhaps highlights the pedagogic challenge of creating effective opportunities for group discussion. Despite this, analysis of the pupil group talk (Appendix 9.6 p.360) does demonstrate that teachers can successfully scaffold productive peer group talk when they require pupils to hypothesise and when they facilitate the development and maintenance of an Intermental Development Zone (Mercer, 2000) within a group. However, construction of a collective understanding was not always specified by teachers as their vision for peer group discussion tasks, even when the talk emerging was productive. An important but somewhat less ambitious aim was given for group work; that it would provide opportunities for pupil engagement through talk and enable pupils to find out and exchange facts. This finding is in agreement with literature (Alexander, 2008c, Resnick, 1999, Scott et al, 2010) but what also emerged was that very often, pupils mirrored these ways of thinking, seeing group talk simply as a space to appropriate ideas from others (Littleton and Mercer, 2013). I would argue that although social considerations such as engagement, confidence and collaboration clearly impact upon the way in which group discussion plays out and how effective it can be, and indeed can even provide a theoretical perspective for viewing group talk (Slavin, 2015), if teacher thinking about talk doesn’t go beyond enabling children to feel comfortable to contribute and providing opportunities for pupils to share out their knowledge, then how it is used to develop understandings will be limited and a move towards talk which is more challenging and exploratory in nature will be constrained.

The inductive analysis of data revealed that participating teachers’ considerations about the use of group talk in science were broad but could be grouped in a thematic way, specifically relating to social, pedagogic, scientific and cognitive aspects. In addition they experienced a web of interrelated tensions with the use of peer group discussion. Pupils’ ways of thinking about group talk were less broad but could also be grouped in the same thematic fashion as teachers. Some of the tensions experienced by teachers were related to time and accountability issues and pupils’ attitudes towards group talk and perceptions about how it could benefit their learning. In addition, teachers felt a pressure for pupils to simply collect the correct scientific knowledge and technical vocabulary. Such tensions and dilemmas cause complexity
and apparent uncertainty and in the Deweyan sense this can be considered a useful obstacle, being a foundation for reflective thinking. However, they can also create inconsistencies between theory and classroom practice (Mansour, 2013). Findings centred on the competing belief sets around ownership and control of learning presented in Chapter Five clearly demonstrate this as tensions emerging from the desire to control the classroom and the learning inhibited the teachers’ enactment of espoused epistemological ideals and social constructivist positions. The constructivist notion of pupil ownership was an ongoing issue for the participating teachers. A pivotal factor in beginning to reconcile the tension they experienced in this area, was reflection on their own practice but also upon their pupils’ contributions. Pupils very often voiced their desire for a deep involvement in learning opportunities and their perspectives alongside their classroom talk became a powerful force which shaped their teacher’s ongoing use of dialogic opportunities and ultimately teachers’ epistemological beliefs about learners and learning. In this way the teachers, in dialogue with their pupils, constructed new professional understandings (Vygotsky, 1986).

Findings emerging from data presented in Chapter 6 show that an important dimension of teacher thinking was focussed on the way in which group talk could enable pupils to work as classroom scientists engaged in the exploratory and creative process of inquiry. Inquiry activities which engaged children in collaborative dialogue around practical tasks did not necessarily lead to a productive exchange of ideas yet the provision of activities where the focus for talk was on specific high order epistemic features of inquiry did often facilitate interesting episodes of productive talk. This surfacing classroom practice provided children with heightened opportunities to begin to understand that science is more than just the learning of facts and vocabulary or the carrying out of a practical procedure; that science is a humanistic way of knowing (Dewey, 1910). As active participants in this emerging classroom culture, with new aspects of science learning valued and highlighted pupils were perhaps afforded spaces to develop vicarious understandings of the nature of science (Duschl, 2004). In this way potential opportunities to enhance scientific literacy, an important goal of science learning were developed through the facilitation of peer group talk. However,
teachers were at times constrained from this practice by their competing beliefs about science learning as being about the reproduction of knowledge and use of technical vocabulary.

The data presented in this thesis has enabled me to gain insights which undoubtedly only just begin to answer the main research question. The teachers in this project facilitated pupils’ productive group talk by providing opportunities for them to take ownership of their learning, by ensuring they had a common understanding from which to work when without the teacher and by engaging them in discussion focussed upon higher order epistemic features of the scientific inquiry process. For these practitioners the process of using group talk was complex and certainly suffused with tension however, reflection upon learning opportunities provided one way to move forward and consolidate ideal epistemological beliefs.

8.4. Contribution to knowledge – theoretical and methodological

This case study into teachers’ thinking about and use of peer group discussion in primary science across an academic year makes a contribution to current understandings in both a theoretical and a methodological way. From a theoretical perspective, by making links between the bodies of literature related to teacher thinking and peer group talk, rich descriptions of classroom practice woven with participant perspectives have been possible. These reveal situated understandings of teachers and pupils using group talk in science and they illuminate the implicit, myriad challenges faced during routine practice. Illustrated by an exploration of networks of interrelated, sometimes competing beliefs which influence practice, the complexity of using a dialogic approach in primary science is exposed. This thesis provides valuable nuanced accounts of teachers’ shifting epistemological beliefs and charts the impact upon pupils’ peer group discussion. The insights into teachers’ routine ways of working which this thesis presents are important for the development of a critical understanding of productive peer group dialogue in primary science and how best it may be promoted. In these ways the study not only adds to the established understanding of peer group talk and contributes to the discussion around how to facilitate productive peer group talk in primary science but also extends the body of
literature around primary teachers’ thinking about the routine use of classroom talk, where our understanding is less broad. Furthermore, as was highlighted in Chapter 2, the literature is not well populated with studies on pupils’ ways of thinking about peer group talk and therefore this study is important because the voice of pupils has been heard.

Through this thesis I have identified apparent changes in teacher thinking in relation to pupil ownership and the use of peer group talk for scientific inquiry and these not only provide potential transferable themes for consideration by other practitioners but also enable the conceptual framework of teacher thinking that was presented in Chapter 2 to be seen as dynamic. With shifting epistemological beliefs, opportunities for pupils to actively engage in dialogic activity in science were reinvented by teachers. Classroom cultural structures expanded across time, evolved through social processes (Wertsch and Tulviste, 1998) and were renegotiated (Bruner, 1986). This process occurred under the influence of constraints, both internal and external but was supported by the theoretical, pedagogical structures of scientific inquiry and constructivism.

The evidence presented in this thesis supports the argument that a process of reflection upon classroom practice is a catalyst for teacher development. By exploring the subtle changes in epistemological beliefs, I have unearthed examples of the impact of reflective thinking and particularly the role of transcript data in that process; both of the peer groups talking within science lessons and of pupils reflecting on such learning opportunities. This finding will be of interest to those in the field of teacher development who seek to design programmes which enable teachers to foster productive dialogic activity in their classrooms.

The data collection for the research was based on an iterative design with pupil transcript data being collated and fed back to teachers and reflections collected across time through an oral diary. From a methodological perspective the contribution of this study is to our understandings of how teacher thinking about classroom talk may be studied. Within the design of this study, the continual process of observation and recording of peer group talk provided an invaluable accumulation of evidence of
teacher thinking about peer group talk across an academic year. This feature could be utilised in further studies of classroom talk.

This research, concerned with the learning dialogue of children, in turn held at its heart a process of dialogue between researcher and teacher in order to attempt to explore through reflective oral diaries how a practitioner thinks about, plans for and organises successful group talk in science. The oral diary became not only a place for the construction of professional knowledge but also provided a flexible way to collect the teachers’ fresh post lesson reflective thinking. Consequently, it was an invaluable source of data and across time, told a story of teachers building bridges to new beliefs regarding the use of talk in science. In addition, the diary entry process provided a space for building rapport and the regular connection between researcher and participant enabled metaphorical bridges to be constructed, spanning the gap between participant and researcher (Hewitt, 2015) (See Appendix 11 p.396).

Finally, the peer group talk data set not only provides an anchor for the claims about teacher thinking which are presented in this thesis but is material for analysis beyond that directly relevant to the research questions of this inquiry and will be a resource for separate academic outputs.

8.5. Implications

This thesis has presented evidence that the teachers’ use of peer group talk in science is underpinned by epistemological beliefs related to pupil ownership, science and science learning and they are therefore relevant in the debate around how to facilitate group talk in science. This leads me to propose that an explicit consideration of these aspects of teacher thinking should complement teacher development programmes which aim to introduce or consolidate a dialogic pedagogy in primary science classrooms.

The findings provide a range of considerations which may be valuable for pre and in-service teacher professional development programmes, which aim to promote the classroom use of peer group talk. Key considerations include:
Programmes should enable practitioners to not only gain an appreciation for the importance of talk as part of the learning process in classrooms but also to develop a strong understanding of and aspiration for the collective thinking potential. This in turn, may enable them to mediate learning opportunities through the creation of IDZs that are intended rather than unrecognised.

An exploration of epistemological beliefs about pupil ownership and about science and science learning may be useful starting point for programmes. If practitioners are simply invited to get children engaged, collaborating and talking or if strategies for the successful implementation of peer group talk are merely demonstrated and disseminated to them without an acknowledgement of the impact of beliefs, it is possible they will find limited success. Teachers’ beliefs not only shape practice but also the way they interpret pedagogical approaches. Therefore a consideration of epistemological beliefs about the role of the learner and about science and science learning should be part of developing teachers’ awareness and understanding of how best to facilitate pupil group talk so that they can construct a wide range of opportunities for children to work and talk as independent scientists in the classroom.

Acknowledging the complexity inherent in applying dialogic pedagogy and discussing the range of accompanying tensions is important.

Reflection on classroom practice should be a dimension of programmes, with the use of pupil transcript data as a basis for this being desirable.

In addition to these wider implications, from a more personal perspective my use of a research journal, in particular throughout the data collection phase and then through its review during the writing up of this thesis, was invaluable in developing a reflective and reflexive approach. As a novice researcher this has implications for my developing practice and I will seek to embed this methodological tool in any future study with which I become involved.

8.6. Limitations and future research
There are of course limitations with this study. Whilst I understand that one of the powerful benefits of case study is its potential to present in depth and transferable
stories and findings cannot be generalised, I am also aware that the scope of this study is very small and the findings are highly contextualised. The participants were three Year 4 teachers and their classes of children, with a total of fifteen being involved in the focus group work. I acknowledge that this is not a large number with which to conduct the study and future research could investigate more widely the nature of teacher thinking about peer group talk in science.

Other limitations derive from some of the data collection methods which I have previously reflected upon in Chapter 3. The time allowed for the oral diary entries was limited and therefore the extent to which they could capture the full range of teacher thinking should be questioned. The interviews with the focus group of pupils did not always reveal in depth responses and therefore perhaps their full stories were not captured. Furthermore, during this study I worked independently, as an individual researcher and as such the analysis of data was carried out by only one person. Although I was careful to be open when coding the data, the possibility exists that I may have overlooked something which another may have identified. In future research, working with colleagues on the coding in order to cross check during this phase of the analysis would be beneficial.

The transcripts of pupil group talk and the focus group interviews provided material upon which the teacher could reflect during the course of the study. This was a valuable aspect to the study and was at times a catalyst for developments in teacher thinking as has been explored through the analysis chapters of this thesis. However, the time involved in transcribing the group talk recordings was hugely significant and when combined with the deadline of returning transcripts to participating teachers before the next observed lesson, a barrier to this type of design being used widely is clearly evident.

I have not defined this study as an intervention, stating that the intention was to research routine practice. However, my presence in the classroom, the demands I made of participants, the data I fed back and the questions I asked will have had an impact upon the context and therefore, questions about the whether I am able to draw conclusions about the everyday practice of teachers should be raised. As a result
of this study, further research could be conducted which explores other practitioners’ experiences of using talk in their everyday science teaching and the ways in which they balance inherent tension. Gaining the pupils’ perspective on their use of talk in science presented me with interesting challenges as a novice researcher; however they provided an important perspective on classroom practice in this study. Further research which seeks to reveal pupils’ ideas about how dialogue enables their science learning can only be of benefit to our understanding of the pedagogy of group talk in action.
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a) Hypothesising

Extract 6: Dissolving

Extract 7: Atoms

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b) Using the IDZ to analyse classroom talk - children sharing ideas, evaluating them and coming to a consensus

Extract 9: Bones

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APPENDIX 10 – DEFINING PUPIL OWNERSHIP OF LEARNING
Appendix 1 – Ethical approval and informed consent documents

Appendix 1.1 – Ethical approval document

University of Leicester Ethics Review Sign Off Document

To: ELIZABETH Hewitt

Subject: Ethical Application Ref: eh130-4725

(Please quote this ref on all correspondence)

13/04/2012 17:03:38
School of Education
Project Title: Effective Teaching Strategies for Group Talk in Developing Children’s Scientific Understanding

Thank you for submitting your application which has been considered. This study has been given ethical approval, subject to any conditions quoted in the attached notes.

Any significant departure from the programme of research as outlined in the application for research ethics approval (such as changes in methodological approach, large delays in commencement of research, additional forms of data collection or major expansions in sample size) must be reported to your Departmental Research Ethics Officer. Approval is given on the understanding that the University Research Ethics Code of Practice and other research ethics guidelines and protocols will be compiled with

- http://www2.le.ac.uk/institution/committees/research-ethics/code-of-practice
- http://www.le.ac.uk/safety/

The following is a record of correspondence notes from your application eh130-4725.

Please ensure that any proviso notes have been adhered to:-

Apr 13 2012 3:10PM This application has been submitted because a previous application that was approved last year, had run over its suggested time frame. The research presented here, which remains the same as that which had obtained approval last year, has been postponed due to my work commitments and so has not taken place within the expected/approved time frame. I have within this application allowed myself more time to complete the project.

--- END OF NOTES ---
Appendix 1.2 Letter to Head Teachers

The University of Leicester

E Hewitt
School of Education
The University of Leicester
21 University Road
Leicester
LE1 7RF
email: eh130@le.ac.uk

Dear X,

I am writing with regard to a research project that I am working on as part of my postgraduate degree and I would be really grateful if you would consider your school’s participation in the data collection phase of this study. I have selected your school as a potential participant due to its size and catchment.

I am a qualified teacher with 16 years primary classroom experience and a special interest in the teaching and learning of science. I am currently working as a tutor on the Primary PGCE at the University of Leicester and also studying for a PhD through research which focuses on the way in which children learn science through peer group discussion. I am specifically investigating the strategies that Year 4 teachers use in order to engage children in purposeful pupil group talk and how this relates to their thinking prior to the classroom activity.

The project would take place over a year, beginning at the end of the summer term 2012 with a teacher interview. Subsequent classroom observations and audio recordings of pupil discussion would take place at intervals over the course of the following year. A brief interview with both the teacher and then the focus children would occur after each classroom session. The study has already been piloted and as a teacher myself, I have designed it to have as little impact as possible on the practitioner’s time.

I would be most appreciative if you would consider your school’s participation in this case study research project and I shall contact you in the very near future to follow up on this letter and discuss whether you may be interested. I have attached an information sheet about the study for your reference.

Yours sincerely

Liz Hewitt
Appendix 1.3 Research project information sheet

**Full title of Project:** Effective Teaching Strategies for Using Group Talk in the Development of Children’s Scientific Conceptual Understanding
Elizabeth Hewitt, Postgraduate Research Student, School of Education, University of Leicester

- I am a PhD student at the University of Leicester and my research project aims to investigate the ways that Yr4 teachers use group talk most effectively in the primary science classroom in order to develop and enhance their pupils’ scientific understanding.
- I am a qualified teacher with 16 years primary classroom experience. I have a special interest in the teaching and learning of science, have been a science coordinator and assisted colleagues in the planning and preparation of science across KS1 and 2. I currently work as a science tutor on the Primary PGCE course at the University of Leicester.
- The study is planned to take place over the course of a year, beginning with a teacher interview at the end of the summer term. During each term over the following academic year, I will visit the school three times to collect the classroom and interview data detailed below.
- During the study, some science sessions will be observed. As part of this observation, audio recordings of talk occurring in the children's groups will take place. In addition, notes about the session will be made in order to put the group talk in context and notes will also be taken about the interactions occurring in the observed group.
- The choice of focus group to be observed in detail will be discussed with the teacher before the study, in order to draw on their knowledge of the children.
- The audio recordings will be transcribed, kept confidentially and used anonymously in any subsequent writing. Only the researcher, the researcher's supervisor and the teacher concerned will have access to the recordings and transcriptions. Audio recordings made of group work may be used as part of any later feedback sessions to the teacher of the class where the recording was made.
- The study will involve an initial interview with the teacher, the aim of which is to uncover thoughts and beliefs about the use of talk in the science classroom. After each observed classroom session a brief interview with the teacher is planned, of about ten minutes. The aim is to capture the teacher's viewpoint of the learning taking place through the talk in the sessions. Any information collected from the interviews will be kept confidentially and only the researcher, the researcher's supervisor and the teacher concerned will have access to this information. Any reference to the interviews in subsequent writing will be made anonymously.
- The study will also involve brief interviews with the focus group of observed children. The aim of this is to establish their gains in scientific understanding from the sessions observed and the way in which they valued the talk strategies employed. Again, the information will be kept confidentially and used anonymously.
- The study will engage the teacher in a cycle of reflection on practice over the use of group talk in science.
- It may also be desirable for the researcher to look at the children's written work to identify their scientific understandings.
- If you have any concerns during the study you will be able to discuss them with the researcher or contact the School of Education at the University of Leicester, where you will be put in touch with my supervisor.
Appendix 1.4 Informed consent document for teacher

Full title of Project: Effective Teaching Strategies for Using Group Talk in the Development of Children’s Scientific Conceptual Understanding

Elizabeth Hewitt, Postgraduate Research Student, School of Education, University of Leicester

1. I confirm that I have read and understand the information sheet for the above study and have had the opportunity to ask questions.

2. I understand that my participation is voluntary and that I am free to ask questions, express concerns or withdraw at any time, without giving a reason.

3. I understand that my participation in this project will involve the observation of certain science lessons, the audio recording of group talk in my class, giving short interviews with the researcher and the use of a reflective journal to map ideas about teaching.

4. I understand that the information provided by me will be held confidentially, such that only the researcher can trace this information back to me individually. I understand that my data will be anonymised at the end of the study and that after this point no-one will be able to trace my information back to me. The information will be retained until the end of the study when it will be destroyed. I understand that I can ask for the information I provide to be destroyed at any time up until the data has been anonymised and I can have access to the information up until the data has been anonymised.

5. I understand that data will be used to form the basis of academic writing which may be published so that good practice may be shared with others in the field of education.

6. I also understand that at the end of the study I will be provided with feedback on the study.

7. I agree to any interviews being audio recorded

8. I agree to any classroom interactions being audio recorded

9. I agree to the use of anonymised quotes in publications

I, ________________________________ consent to participate in the study conducted by Elizabeth Hewitt, School of Education, University of Leicester.

Date ______________________Signature ____________________________________________

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Appendix 1.5 Letter to parents and children

Dear Parent/Carer,

Your child’s school has been approached to take part in an educational research project and has agreed to be a participant in the study, which aims to investigate children’s development of scientific understanding through group discussion.

I am a qualified teacher with 16 years primary classroom experience and a special interest in the teaching and learning of science. I am currently a tutor on the Primary PGCE course at the University of Leicester and also a postgraduate research student. My study focuses on the strategies that teachers use in order to promote the use of purposeful pupil group talk in the development of scientific understanding. To this end, I would like to work with your child’s class teacher during some of their normal science lessons, making observations and keeping notes on how the pupils are engaged and how effectively their group talk helps build their understanding in science. I will make some audio recordings of children’s group work. I would also like interview some children in order to establish their views of the science talk in class. In all cases, the information gained would be kept anonymous and any pupil asked to take part in an interview would be able to withdraw at any time if they did not want to share their views. The information and recordings collected would be held in a secure place to ensure the views of the pupil remain anonymous and will only be used for analysis in order to aid my understanding of how successful particular teaching strategies have been. It is hoped that the information collected will be used to form the basis of academic writing and possible publication in order to share good practice with others in the field of education.

If you have any further questions concerning this matter, please feel free to contact me. If you are happy for your child to be involved in the project and collection of data, please complete the slip below and return it to school.

Yours faithfully

Elizabeth Hewitt

We/I have read the information provided and we/I am happy for my child to take part in the research project described above and for them to be involved in the collection of data.

Name of child __________________________

Signature______________________________  Date____________________
Appendix 2 – Participants

Appendix 2.1 - Pen portraits of participants

Emma

Emma has been a teacher for 17 years, working in a range of settings in the UK and also in Kenya. Her experience is predominately in Key Stage 2, although she has taught her specialist subject of Music across the entire primary age range. When asked about a philosophy which guides her teaching she refers to the importance of viewing children as lifelong learners and of providing them with high and clear expectations, stating a belief that children will do what they can to succeed if given the right circumstances. She also mentions the importance of providing real classroom experiences, based on children’s prior knowledge, that children’s engagement comes from them feeling responsible for their own learning and that pupil talk is an essential feature of classroom environment.

Arun

Arun is new to teaching, just beginning his second year when this project began. During his training year he gained experience in a suburban school, two different inner city schools which serve communities with a high proportion of children with English as a Second Language and he had also worked previously as a teaching assistant in a secondary school. Before becoming a teacher Arun worked for 16 years as a subeditor for a large local newspaper, after completing an Electronic Engineering degree at university.

He made the decision to change career with excitement and regularly talks throughout the project about persevering despite high workload issues. When asked about the philosophy which guides his approach to teaching, he talked about having high expectations of pupils and the importance of giving them plenty of feedback. He talked about wanting to gain confidence with his own understanding of how children learn through their own involvement, rather than because the teacher has covered some area of content.
Arun said that he felt confident with teaching all areas of the curriculum, but especially enjoyed science possibly due to his academic background. At the end of his first year of teaching Arun was asked by the Head Teacher to be science coordinator, a role which he hoped would be informed in some way by working on this project.

**Simon**

Simon has been a teacher for seven years and has experienced work in a range of settings from a village school to a large urban school. At the start of the project he had been in his current post for three years and had always taught lower Key Stage Two children. Previously Simon had completed a degree in Health Studies and a Masters in Ergonomics and after this academic phase of his life, worked in ergonomics and production for almost four years. He made a career move when redundancy was offered and he chose teaching as a career based on his experiences of swimming coaching and lifesaving teaching with children. He talks about ICT as his specialist area of the curriculum and when asked about his guiding philosophy for teaching, he talked about enjoying it, being enthusiastic about learning and the impact this has on the children’s level of enjoyment and engagement in school.
Appendix 2.2 Flowchart to show the process of recruiting participants

I created a list of criteria for selecting schools to contact about participating in the study:

- School I was unfamiliar with
- Good/outstanding as judged by Ofsted
- Mixed catchment area
- EAL not above average
- Large enough school to have single year class structure
- Year 4 teacher who was relatively experienced, interested in science teaching and learning and had an appreciation of the importance of dialogue for learning—this criterion was preferred but could not be targeted at this stage.

From this and using the local authority school database, I created a list of twelve schools which were geographically convenient and a standby list of a further six—a time consuming but not difficult process. I made the decision to approach schools personally rather than just send out a lot of information leaflets and see what happened.

I made phone calls to schools to try and speak with Heads; some immediate ‘no’ responses, some ‘maybes’ (tried not to take rejection personally!). I mailed out project information to schools that were in latter group.

I made follow up phone calls to ‘maybe’ schools but some possibilities turned out to be ‘dead ends’. Arrangements were made to visit two schools that said they were interested and I met Heads to have discussion and answer questions. I then contacted the teachers and arranged to meet for discussion. Two schools were now sorted but my list was exhausted.

I created a new list—schools which fitted the criteria detailed above but ones which had a Head Teacher with whom I was familiar; gaining access is easier to negotiate if the researcher has contacts to the population (Thomas, 2009). After phone calls to the two schools on the list I had one ‘yes’ and one ‘maybe’. I sent information leaflets to both schools and subsequently met with Head and Year 4 teacher in one of them. The second school, who were a ‘maybe’, subsequently contacted me to say they had decided not to take part as they were having a staffing restructure.

Three schools were now recruited. Consent was granted from all Heads and participating Yr4 teachers and their class of pupils’ parents. Getting into the field had been a real challenge but I was now on my way!
Appendix 3 – Data collection documents

Appendix 3.1 Teacher semi-structured interview schedules

Initial interview

- When you are planning for science learning in the classroom what are the factors that you consider to be most important? What opportunities do you prioritise/include?
- Do you feel that group talk is beneficial for children’s learning in science? If so, in what ways is it beneficial?
- In what ways do you use group talk in science?
- In what ways do you feel that group talk in science is different or the same as group talk in other subject areas?
- How confident do you feel about allowing pupils to have the freedom and time to talk in peer groups in science?
- When you are planning for group discussion activities, what do you feel are the important things to consider?
- Are there any specific strategies that you have in place for enabling group talk? What strategies do you feel work most successfully for you?
- Can you describe any particular challenges associated with the use of group talk in science?
- In what ways do you establish a culture of talk for learning in your classroom?
- In what ways do you feel the pupils themselves value the discussion activities in science?

Final interview

- In what ways has your awareness or use of group talk altered over the process of the project? In what ways do you now successfully use group talk in science? When? How is it planned for? Are there any aspects of your teaching in this way that have not altered?
- What strategies or approaches have you developed for using group discussion in science? In what ways have they been successful (or not)?
• What critical issues in planning for group talk have emerged and how have you dealt with them? When you are planning for group discussion activities, what do you now feel are the important things to consider?
• Can you describe any particular challenges that you have encountered this year with planning for and using group talk in science?
• In what ways do you feel that group talk in science is different or the same as group talk in other subject areas?
• How confident do you feel about allowing pupils to have the freedom and time to talk in peer groups in science? In what way has this altered through the project?
• In what ways do you value group discussion? How does this relate to the way in which you value the whole class discussion forum?
• In what ways do you feel the pupils themselves value the discussion activities in science?
• What are your conclusions about what productive talk in science looks like and how you can facilitate this?
• How useful have you found the reflective cycle (use of reflective report) in terms of feeding into thinking about/planning for group discussion?
• How did the pupil interview transcriptions impact on the way in which you reflected?
• How did the group discussion transcriptions impact on the way in which you reflected?
• Were there any critical points for your thinking in the project?
Appendix 3.2 Card sort interview

Elements for card sort – the set from which teachers could select and to which they could add for the free flowing discussion.

* (DfES, 2003)

- Talk partners
- Role play
- Jigsawing *
- Envoying *
- Snowballing *
- Information sharing
- Discussing prior learning
- Think-pair-share *
- Thought shower
- Concept Cartoon
- Inquiry activity
- Practicing vocabulary
- Reflect on learning
- Problem solving
Appendix 3.3 Observation recording sheet

<table>
<thead>
<tr>
<th>Date/Time</th>
<th>Class/Number of Pupils</th>
<th>Groupings</th>
<th>Observed Group</th>
<th>Support Staff</th>
</tr>
</thead>
</table>

Focus of Lesson/Position of lesson in sequence:

Activity Description:

Resources:

Learning Environment:

<table>
<thead>
<tr>
<th>Time</th>
<th>Teacher input e.g. discussion/comment/gesture/intervention/response/transition:</th>
</tr>
</thead>
</table>

Data Code:
Appendix 3.4 Pupil focus group interview schedule

What did you like about that particular science lesson?

Is there anything that you didn’t like?

What science did you learn about in the lesson?

Which activities did you like most? How did they help you today?

Which part of the lesson did you learn the most in? Why do you think that part helped you learn most?

Who helped you to learn in the lesson today? Why was that?

Who did you talk to today in your lesson? How did the talking in groups help with your science learning today? Did you enjoy the group talking today?
Appendix 3.5 Oral diary prompt selection
Can you describe the session today? What went well? What are your feelings or reactions to the group work?

Is there anything that did not go so well with the group discussions and you would try to change if you repeated this?

What decisions did you make when planning the group talk activities today and what are they based upon? What strategies did you decide upon and why?

How did you ensure that all children were able to engage in the talk today?

How did the transcriptions or reflections from last time have an impact on your thinking at all when planning the lesson?

What were you hoping to achieve through the group talk today? What are your conclusions about the learning that took place through the talk today? What enabled that learning to take place?

Were there any critical moments or strategies that had an impact upon the way in which the children were able to talk and learn in their groups?

What do you think was really going on for the pupils? What were the pupils experiencing?

What kinds of talk did you expect/hope to hear today? What specifically did you hear that made you feel that the activity was purposeful?
Appendix 3.6 Optional written teacher reflection sheets

Dear..., 

Part of the research project involves engagement in a reflective cycle, which begins when teachers think about their lessons and decide how they went and why. I will initiate a reflective oral diary entry with you sometime after the session and this will take up to ten minutes of your time. This will be recorded to allow for later playback.

After the reflective oral diary entry, I will write a short report and send it to you, so that you can verify that it contains an accurate record of your dialogue. I will also send to you a transcription of the peer group talk which I recorded. I am sure you will find this interesting and you may also find it useful.

This folder is made available to you so that if you choose to reflect more upon the science sessions at any point, there is a framework designed to structure thinking. You may decide you would prefer to make free notes on the paper enclosed or around the cyclical diagram (I have enclosed a few), or in another way that works best for you. I hope you find it worthwhile!

Thank you again for your cooperation and collaboration in this study.

Best wishes

Liz
Figure A 3.6: Reflective cycle diagram provided for use by participants

Reflective Cycle

Description
What happened?

Feelings
What were you feeling and thinking?

Evaluation
What was good and bad about the event?

Analysis
What sense can you make of the situation?

Conclusion
What else could you have done?

Action Plan
If it arose again, what would you do?

Reflective Cycle
(Gibbs 1988, in Scaife 2010)
Based upon Kolb’s cycle of experiential learning (1984)
### Appendix 4 – Data source identification key

<table>
<thead>
<tr>
<th>Data Source</th>
<th>Identifying Code in thesis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Interviews pre and post observation phase</td>
<td></td>
</tr>
<tr>
<td>1. Semi-structured – based around a set of guiding questions</td>
<td>(Name) Initial Interview 1&lt;br&gt;(Name) Final Interview 1&lt;br&gt;e.g. Emma Initial Interview 1</td>
</tr>
<tr>
<td>2. Elicitation - based around card sort activity</td>
<td>(Name) Initial Interview 2&lt;br&gt;(Name) Final Interview 2&lt;br&gt;e.g. Emma Final Interview 2</td>
</tr>
<tr>
<td>Lesson Observations</td>
<td>Using participant name and lesson number as an identifier&lt;br&gt;e.g. Emma Lesson Observation 1</td>
</tr>
<tr>
<td>Reflective Oral Diary</td>
<td>Using participant name and lesson number as an identifier&lt;br&gt;e.g. Emma Oral Diary 1</td>
</tr>
<tr>
<td>Focus Group Pupil Interview</td>
<td>Using teacher name and lesson number as an identifier&lt;br&gt;e.g. Emma Pupil FG Interview 1</td>
</tr>
<tr>
<td>Researcher Journal</td>
<td>Research Journal, date</td>
</tr>
<tr>
<td>Peer Group Discussion Transcripts</td>
<td>Using teacher name and lesson number as an identifier&lt;br&gt;e.g. Emma Pupil Group Talk 1</td>
</tr>
</tbody>
</table>
Appendix 5 – An exploration of the fluidity of roles in the research process

<table>
<thead>
<tr>
<th>Positionality</th>
<th>Research Journal extracts from visits to Arun’s class - ordered temporally</th>
</tr>
</thead>
<tbody>
<tr>
<td>Outsider</td>
<td>As I arrived at school today I did feel really nervous – how would it go, would the teacher mind, be shy, feel pressured? Would I be able to answer any questions? Would I rather be in the teacher’s position?? As I signed in I realised that Arun was waiting for me in the front entrance. I didn’t expect this attention -perhaps he feels nervous too. Does he know how grateful I am to have him as a participant!? But despite the fact that I am at the mercy of the school, for inviting me and agreeing to be part of study, perhaps the situation is that I am seen in a position of power (working now at the university and my information sheets were designed to be authoritative). Perhaps this actually does make the teachers feel under pressure, watched, under the microscope, insecure. This is important; my study relies on ‘good’ open data. <strong>Research Journal July 31st 2012</strong></td>
</tr>
<tr>
<td>Outsider with some impact from insider knowledge</td>
<td>I can have conversations with teachers in a comfortable way because I understand and know their job but I am also not part of their classroom. Despite my efforts to integrate, can it really happen unless I am there all the time? And so I am outside the true culture of these classrooms. Although I am able to observe with understanding and pick up message and signals due to my experience, I will never really be a part of it even as I get towards the end probably. Ideally it would be good to be part of the classroom more and find out how the culture of talk is set up but this is not practical in the slightest. <strong>Research Journal October 6th</strong></td>
</tr>
<tr>
<td>Moving inside</td>
<td>The children seem to be accepting me a little; they turned and asked me a question today in the group session as if I were just a normal member of their class team. This feels good <strong>Research Journal October 31st</strong></td>
</tr>
<tr>
<td></td>
<td>As I arrived the children greeted me and knew I was coming. The teacher sent the children to assembly and we chatted for about twenty minutes about teaching and workloads. It was very interesting that the teacher felt comfortable enough to tell me that he was thinking that he couldn’t see himself doing this as a job long term, that the work and the pressure was all a little too much. We talked about the multi-faceted nature of the job and the demands it makes upon you and your family but also the highs you can get and that keep you motivated. It was a very frank discussion, after which he apologised for letting it all out on me! <strong>Research Journal November 13th</strong></td>
</tr>
<tr>
<td>Date</td>
<td>Event Description</td>
</tr>
<tr>
<td>------------</td>
<td>------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>January 28</td>
<td>The session today did not go as well as the teacher had hoped I think and it suddenly became obvious after the lesson that he wanted feedback on his teaching – this has never happened before in the project. After the usual interview when the recorder had been switched off I was asked if I could tell him how he could have improved the lesson. This made me feel slightly uncomfortable as I don’t feel that I am there to judge and have put that out explicitly from the start. But on the other hand the teacher wants to share ideas and develop his thinking and so pressured me for my thoughts. I was unsure how to proceed and so reiterating that I wasn’t there to judge or evaluate in the ways he was looking for I did engage in a general discussion on the merits of trying out different kinds of timing for lessons and sometimes splitting them up smaller parts or using more than one lesson for longer things. However I felt very uncomfortable with this apparent change of role that was forced upon me – something different than I had said I would be.</td>
</tr>
<tr>
<td>February 20</td>
<td>The teacher greeted me with some jobs to be done; helping a child with his early morning maths, giving out equipment and working with groups.</td>
</tr>
<tr>
<td>March 14</td>
<td>Visit to school as usual but interestingly this time the teacher did not feel inclined to apologise or make a lot of defensive comments about the behaviour that was exhibited today. Am I accepted as part of the classroom more? When I joined in with the activate exercise the children did not all stare at me and giggle this time – some did but most looked at me, smiled and then looked away.</td>
</tr>
<tr>
<td>April 16</td>
<td>As an aside at the end of the visit, I mentioned that it would be interesting to hear the children talking without the set roles being given. Making suggestions, even obliquely, seems to be coming from an outsider perspective as I have my own agenda at heart and this highlights the ‘external’. Maybe the whole thing is a balancing act - keeping the show on the road.</td>
</tr>
</tbody>
</table>

*Research Journal January 28th*

*Research Journal February 20th*

*Research Journal March 14th*

*Research Journal April 16th*
<table>
<thead>
<tr>
<th>Table Heading</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>Developing as insider</td>
<td>At the end of the lesson, at break, after we had done the reflective interview, the teacher began to tell me how proud he was of some literacy work. He showed me some children’s writing and how he had built a topic up, how long it had taken him, how intense he found it. He also showed me his levelling/assessments and as the new ‘after break’ TA came in we had a discussion about how the class had been behaving, performing etc. I felt for a short time as if I was part of the team just for that one morning; privy to professional conversations, asked to give a contribution, sharing a joke.</td>
</tr>
<tr>
<td>Placed as outsider by participant</td>
<td>Being an insider or more precisely someone with insider understanding – this is important. But still it is not all rosy – it is apparent that there is still a tension. Arun asks me for a copy of the interview questions ahead of the final interview – will there be any technical questions or tricky ones he asks.</td>
</tr>
<tr>
<td>Outsider with ‘transient’ insider status?</td>
<td>Was I an insider or outsider? Well as I have been able to walk away and think that I may not see that classroom again and feel some relief that I have my ‘stuff’ to go away with, then I must conclude that I was really an outsider. Perhaps pretending to be an insider, trying hard for all the right reasons to be a partner and give something and share my own little stories about teaching so the participant knew I was the ‘real deal’ and not just some student who doesn’t know what it’s like to be a primary school teacher. Perhaps in reality, I sat at the fringes of the classroom, practically and conceptually. I was passing through. Someone who understood the workings/stresses/excitement and shared in them where I could but also someone transient.</td>
</tr>
</tbody>
</table>
Appendix 6 - An exploration of how my positioning as a researcher affected dynamics in the field and data collection process of this research project

<table>
<thead>
<tr>
<th>Background of Researcher</th>
<th>Positionality</th>
<th>Consideration of impact on dynamics in the field and/or on data production</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge of participants and of specific research contexts</td>
<td>Insider</td>
<td>The pilot phase took place in a school where I had recently worked as a teacher therefore I had familiarity of the location and the participants. There were great benefits for me in gaining access in the first place and in understanding the culture of the research setting. There were well developed relationships with pupils and staff meaning I was able to quickly move into pupil group observations with a minimum of intrusion. However, perhaps as an ex-colleague, the participating teacher felt some obligation to be part of the study when I asked, feeling pressured by familiarity into consent. It may also have been awkward to be observed by someone known quite closely in a different capacity. In addition, I could possibly take situations and experiences for granted due to familiarity with context which could lead to data being superficially interpreted. In the main study, developing relationships over time with participants and getting to the point where situations were more comfortable and interactions relaxed meant that there was more potential to achieve in depth, honest and faithful data. However there was also the potential to become over familiar which could introduce an element of bias. Even when I was no longer visiting the classrooms and I had taken everything away from the context to stand back and analyse, the time spent with the participants means that I could have mind’s eye on the setting, remembering conversations and interactions. I now have a shared history with the participants, through which all analysis and interpretations will filter.</td>
</tr>
<tr>
<td>No knowledge of participants or specific research settings.</td>
<td>Outsider</td>
<td>At the start of the main study I was an unknown entity for participants. I did not know the staff, pupils or any of the local political contexts of the settings and could not blend in. No relationship had developed at the outset therefore participants may have found it challenging to openly share ideas and classroom space and a lack of familiarity and understanding of perspective of research could set up imbalance in power dynamic.</td>
</tr>
<tr>
<td>Professional practical knowledge, understanding of primary school culture and the issue under study</td>
<td>Insider</td>
<td>I was able to make connections and demonstrate empathetic understanding with participants due to the fact that my own professional background paralleled theirs, there was an intersection of professional knowledge which had potential to enable more open and in-depth accounts. Because of my prior experience I could feel at ease in the new classroom environments of the main study, despite being a stranger to the specific settings. This meant that there was minimal culture shock and I could understand and interpret experiences with more confidence than if I was new to the culture. However, I may bring assumptions about what should be happening in primary science and how peer group talk should work which can impact on my observations and interpretations.</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>Member of research arena</td>
<td>Outsider</td>
<td>Establishment of researcher identity not stable and so was under strain in the pilot study which was a context where I had been in a differing professional role. Feeling uncertain in research role could lead to insecurity in employment of data collection methods and possibly lead to lack of clarity. My position as researcher, despite my novice status, may put pressure on participants. They may feel vulnerable to judgement and may feel unsure of the project’s direction or audience. This may have impact upon access to faithful accounts. Participating teachers may also at times see me in a more powerful position in the partnership. This may have led to synthetic classroom experiences, with teachers not drawing on routine, natural practice or to ‘wanting to say the right thing’. I have a research agenda which must be accounted for.</td>
</tr>
</tbody>
</table>
Appendix 7 – Thematic analysis supporting documents

Appendix 7.1 First breakdown of initial interview data

All of the initial interviews were subject to a thematic analysis. In order to organise and clarify emerging notions, I collected them into groups – those centred on the children and what they may gain or demonstrate through the group talk, those centred more on teachers and then finally those around management of practicalities and logistics (Table A7.1).

<table>
<thead>
<tr>
<th>Notions about children</th>
<th>Notions about teachers</th>
<th>Notions about management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement</td>
<td>Ensuring developing understanding (T)</td>
<td>Time (T)</td>
</tr>
<tr>
<td>Collaboration</td>
<td>Teacher as expert</td>
<td>Ground rules</td>
</tr>
<tr>
<td>Confidence</td>
<td>Questioning</td>
<td>Behaviour</td>
</tr>
<tr>
<td>Sharing knowledge</td>
<td>Finding out children’s ideas</td>
<td>Group attributes</td>
</tr>
<tr>
<td>Asking questions</td>
<td>Valuing children’s ideas</td>
<td>Practical Resources</td>
</tr>
<tr>
<td>Justifying ideas</td>
<td>Challenging children’s ideas (T)</td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>(In)security; handing over control (T)</td>
<td></td>
</tr>
<tr>
<td>Taking ownership and responsibility</td>
<td>Subject knowledge (T)</td>
<td></td>
</tr>
<tr>
<td>Being independent</td>
<td>Teacher intervention in group talk (T)</td>
<td></td>
</tr>
<tr>
<td>Generating ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developing communication skills</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Challenging ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Explanation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Using vocabulary</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Seeing value in discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling safe to talk; open forum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaining consensus</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Reasoning</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Although it may perhaps be rather simplistic to group all three teachers’ responses together in this way, and of course not all of them voiced all of these notions, this early identification provided signposting, enabling me to gain a feel for how peer group talk connected to the teaching and learning process for the teacher participants; to see that social issues, such as
involvement, collaboration and the development of confidence through peer group talk were high on the agenda, a point congruent with the literature (Alexander, 2008c, 2000) and that they experienced tension and challenge with the use of group talk in science. It also allowed me to see that the teachers had a view of how they wanted talk to work in their classrooms—through the sharing of ideas, questioning and challenging, justification and explanation— in other words through a process of dialogic inquiry (Wells, 1999).
Appendix 7.2 Breakdown of early oral diary data

Table A7.2: Notions about using group talk referred to by three participating teachers and three focus groups after first academic term of study. Bold items are notions which were more prevalent. Notions marked with a (P) were those referred to by pupils. Those items marked with a (T) denote where there was some feeling of concern or tension expressed around the notion. Those items in italics are new when compared to the initial interview data breakdown previously tabulated.

<table>
<thead>
<tr>
<th>Notions about children</th>
<th>Notions about teachers</th>
<th>Notions about management</th>
</tr>
</thead>
<tbody>
<tr>
<td>Involvement (P)</td>
<td>Ensuring developing understanding (T)</td>
<td>Time (P) (T)</td>
</tr>
<tr>
<td>Collaboration(P)</td>
<td>Teacher as expert (P)</td>
<td>Ground rules</td>
</tr>
<tr>
<td>Confidence (P)</td>
<td>Questioning (P)</td>
<td></td>
</tr>
<tr>
<td>Sharing knowledge (P)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Asking questions(P)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justifying ideas</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td>Finding out children’s ideas</td>
<td>Behaviour</td>
</tr>
<tr>
<td>Taking responsibility</td>
<td>Valuing children’s ideas (P)</td>
<td>Group attributes</td>
</tr>
<tr>
<td>Taking ownership</td>
<td>Challenging children’s ideas (T)</td>
<td>Productivity</td>
</tr>
<tr>
<td>Being independent (P)</td>
<td>(In)security; handing over control (T)</td>
<td>Practical resources</td>
</tr>
<tr>
<td>Active participants and learners</td>
<td>Subject knowledge (T)</td>
<td></td>
</tr>
<tr>
<td>Generating ideas</td>
<td>Teacher intervention in group talk (T)</td>
<td></td>
</tr>
<tr>
<td>Developing communication skills</td>
<td>Clear focus for learning</td>
<td></td>
</tr>
<tr>
<td>Challenging ideas</td>
<td>Consolidating and reinforcing concepts as a whole class; Gaining class consensus (T) (P)</td>
<td></td>
</tr>
<tr>
<td>Explanation (P)</td>
<td>Planning</td>
<td></td>
</tr>
<tr>
<td>Using vocabulary</td>
<td>Assessment</td>
<td></td>
</tr>
<tr>
<td>Seeing value in discussion</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Feeling safe to talk; open forum</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Gaining consensus (P)</td>
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</tr>
<tr>
<td>Reasoning</td>
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<td></td>
</tr>
<tr>
<td>Reflecting on learning</td>
<td></td>
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</tbody>
</table>
After a full term of the project, when two or three lessons had been observed in each classroom, the oral diary data collected to that point were analysed by broadly breaking down the responses, identifying emerging ideas about group talk and adding them to the initial list collated after the first set of interviews. This was done in order to ascertain a picture of notions about teaching and learning using peer group talk that participants seemed to be considering early in the study. The focus pupil group interview data were also looked at for evidence of these notions being important to learners, or indeed if they had different ideas. This new list (Table A7.2) enabled me to see that there were some new ideas that teachers were considering important when thinking about facilitating peer group talk, for example one about working peer group talk around whole class discussion, in order to reinforce and consolidate concepts considered by groups. This particular notion was interesting because the idea of creating a strategic balance emerged through the literature review (Michaels, O'Connor and Resnick, 2008, Mercer and Dawes, 2014, Pimentel and McNeill, 2013, Mortimer and Scott, 2003), because it was mentioned by both teachers and pupils and also referred to in terms of the challenges of using group talk.
Appendix 7.3 Data Summary Grids

1. **Notions emerging from all initial and final interview content**
   Creating this summary enabled me to have an overarching picture, comparing start and finish and was useful in helping to categorise possible themes for more in depth analysis.

2. **Exploratory Talk features evidenced lesson by lesson**
   Creating this kind of summary enabled me to begin to see where the strongest examples of peer group talk may be situated (see Appendix 9.1 for example).

3. **Lesson by lesson oral diary summary for each teacher**
   Creating this kind of summary for each teacher enabled me to gain an overview of how the responses progressed through the year, to identify if there was a story about teaching and learning emerging through the oral diary content.

4. **Lesson by lesson focus pupil group interview summary**
   Creating this kind of summary for each focus group enabled me to gain an overview of how the responses progressed through the year, to identify if there was a learning story emerging through the interview content.

5. **Lesson by lesson summary drawing data sources together**
   Creating this kind of summary for each teacher enabled me to gain an overview of how the data as a whole progressed through the year, to identify if there was a teaching and learning story emerging (see Appendix 8.2 for example).

6. **Themes emerging from final interview content**
   This summary was created at a point when I had read through all of the data sets together and had built a broad mental landscape of them. It was created using final interview data, in order to collect together a ‘final’ picture of each participant teacher’s thinking (see Appendix 7.12 Final interview broad thematic overview).
### Appendix 7.4 Coding grid for teacher initial interview data

<table>
<thead>
<tr>
<th>Overall Theme</th>
<th>Organising Theme - Nodes</th>
<th>Basic Theme - Child Nodes</th>
<th>Number of coding references</th>
<th>Number of teachers coded to the node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ways of thinking about enabling productive talk in science</td>
<td>Pedagogy of using group talk</td>
<td>Uses for talk</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valuing talk</td>
<td>5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dynamic decision making</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Balancing with whole class</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modelling talk</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resources</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subject knowledge</td>
<td>2</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Approach to teaching science</td>
<td></td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td>Developing inquiring scientists</td>
<td></td>
<td>Sharing and challenging ideas</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Independence</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ownership</td>
<td>9</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Inquiry</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NoS</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Reasoning</td>
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<td>2</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Creativity</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Pupil agency</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Considerations, tensions and challenges</td>
<td>Security</td>
<td>13</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Involvement</td>
<td>11</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Classroom culture</td>
<td>7</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Developing understanding</td>
<td>11</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>9</td>
<td>2</td>
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<tr>
<td></td>
<td>Group collaboration</td>
<td>9</td>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td>Engagement</td>
<td>8</td>
<td>3</td>
<td></td>
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<tr>
<td></td>
<td>Inclusion</td>
<td>8</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Extending through talk</td>
<td>5</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Children understanding talk for learning</td>
<td>4</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Time</td>
<td>4</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Accountability</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

A visual representation of the coding for all three initial interviews was created using an Nvivo tree map (Figure A7.4). This shows number of text references coded to each node for all three initial interviews together (colours show the teachers coded: dark green - 3
teachers coded at that node, green 2 teachers and orange 1 teacher coded). The map shows that some themes are more prevalent.

Figure A7.4: Tree map of coding for initial interviews
### Appendix 7.5 Coding grid for teacher final interview data

<table>
<thead>
<tr>
<th>Overall Theme</th>
<th>Organising Theme - Nodes</th>
<th>Basic Theme - Child Nodes</th>
<th>Number of coding references</th>
<th>Number of teachers coded to the node</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ways of thinking about enabling productive talk in science</td>
<td>Pedagogy of using group talk</td>
<td>Uses for talk</td>
<td>24</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Changing practice</td>
<td>20</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valuing talk</td>
<td>19</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher thinking about practice</td>
<td>14</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Balancing with whole class</td>
<td>6</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dynamic decision making</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modelling talk</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>Approach to teaching science</td>
<td></td>
<td>6</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Developing inquiring scientists</td>
<td>Independence</td>
<td>24</td>
<td>3</td>
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<td></td>
<td></td>
<td>Ownership</td>
<td>21</td>
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<td></td>
<td>Inquiry</td>
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<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NoS</td>
<td>16</td>
<td>2</td>
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<tr>
<td></td>
<td></td>
<td>Sharing and challenging ideas</td>
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<td>2</td>
</tr>
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<td></td>
<td></td>
<td>Creativity</td>
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<td>2</td>
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<td></td>
<td></td>
<td>Pupil agency</td>
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<td>2</td>
</tr>
<tr>
<td>Considerations, tensions and challenges</td>
<td>Security</td>
<td>37</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Control</td>
<td>31</td>
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</tr>
<tr>
<td></td>
<td>Classroom culture</td>
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<td></td>
<td>Understanding</td>
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<tr>
<td></td>
<td>Children understanding talk for learning</td>
<td>8</td>
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<td></td>
<td>Group collaboration</td>
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<tr>
<td></td>
<td>Time</td>
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<tr>
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<td>Extending through talk</td>
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</tr>
<tr>
<td></td>
<td>Accountability</td>
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<td>Inclusion</td>
<td>3</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sequencing</td>
<td>2</td>
<td>1</td>
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</tr>
</tbody>
</table>

A visual representation of the coding for all three final interviews was created using an Nvivo tree map (Figure A7.5). This shows number of text references coded to each node for
all three final interviews together (colours show the teachers coded: dark green - 3 teachers coded at that node, green 2 teachers and orange 1 teacher coded). The map shows that some themes are more prevalent and changes from the initial interview tree map are visible.

Figure A7.5: Tree map of coding for final interviews
<table>
<thead>
<tr>
<th>Overall Theme</th>
<th>Organising Theme - Nodes</th>
<th>Basic Theme - Child Nodes</th>
<th>Number of coding references - initial</th>
<th>Number of coding references - final</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ways of thinking about enabling productive talk in science</td>
<td>Pedagogy of using group talk</td>
<td>Uses for talk</td>
<td>9</td>
<td>24</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Valuing talk</td>
<td>5</td>
<td>19</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Dynamic decision making</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Balancing with whole class</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Modelling talk</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Resources</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Subject knowledge</td>
<td>2</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>Changing practice</td>
<td>0</td>
<td>20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Thinking about practice</td>
<td>0</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>General approach to teaching science</td>
<td></td>
<td>8</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td>Developing inquiring scientists</td>
<td>Sharing and challenging ideas</td>
<td>20</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Independence</td>
<td>14</td>
<td>24</td>
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<tr>
<td></td>
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<td>Ownership</td>
<td>9</td>
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<td>Inquiry</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td></td>
<td>NoS</td>
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<td>16</td>
</tr>
<tr>
<td></td>
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<td>Reasoning</td>
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<td>0</td>
</tr>
<tr>
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<td></td>
<td>Creativity</td>
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<tr>
<td></td>
<td></td>
<td>Pupil agency</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Considerations, tensions and challenges</td>
<td>Security</td>
<td>13</td>
<td>37</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Involvement</td>
<td>11</td>
<td>15</td>
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<td>Classroom culture</td>
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<td>Developing understanding</td>
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</tr>
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<td></td>
<td></td>
<td>Control</td>
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<td>Group collaboration</td>
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<td>Engagement</td>
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<td>16</td>
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<td>Inclusion</td>
<td>8</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Extending through talk</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Children understanding talk for learning</td>
<td>4</td>
<td>8</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Time</td>
<td>4</td>
<td>6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Accountability</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Sequencing</td>
<td>0</td>
<td>2</td>
</tr>
</tbody>
</table>
## Appendix 7.7 Coding grid for final card sort interview data

<table>
<thead>
<tr>
<th>Simon Ways of thinking - In order of relative occurrence</th>
<th>Emma Ways of thinking - In order of relative occurrence</th>
<th>Arun Ways of thinking - In order of relative occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being scientific</td>
<td>Sharing to find something new</td>
<td>Spreading Knowledge</td>
</tr>
<tr>
<td>Getting ideas outside</td>
<td>Control</td>
<td>Safety</td>
</tr>
<tr>
<td>Independence</td>
<td>Safety</td>
<td>Freedom to explore ideas</td>
</tr>
<tr>
<td>Assessment for Learning</td>
<td>Assessment for Learning</td>
<td>Being scientific</td>
</tr>
<tr>
<td>Developing understanding</td>
<td>Accountability</td>
<td>Progression of strategies</td>
</tr>
<tr>
<td>Control</td>
<td>Developing understanding</td>
<td>Environment and culture</td>
</tr>
<tr>
<td>Engagement</td>
<td>Engagement</td>
<td>Challenge and questioning</td>
</tr>
<tr>
<td>Consolidation and consensus</td>
<td>Feeder strategy</td>
<td>Assessment for Learning</td>
</tr>
<tr>
<td>Accountability</td>
<td>Challenging and questioning</td>
<td>Concrete knowledge rehearsal</td>
</tr>
<tr>
<td>Communication skills</td>
<td>Time</td>
<td>Control</td>
</tr>
<tr>
<td>Challenge</td>
<td>Participation</td>
<td>Communication skills</td>
</tr>
<tr>
<td>Explanation</td>
<td>Independence</td>
<td>Engagement</td>
</tr>
<tr>
<td>Planning</td>
<td>Importance of different perspective</td>
<td>Planning</td>
</tr>
<tr>
<td>Resistance from pupils</td>
<td>Communication skills</td>
<td>Putting ideas together</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>Time</td>
</tr>
<tr>
<td></td>
<td>Answering questions to gain consensus</td>
<td>Participation and collaboration</td>
</tr>
<tr>
<td></td>
<td>Clarification and consolidation</td>
<td>Feeder strategy</td>
</tr>
</tbody>
</table>
Appendix 7.8 Visual representation of each teacher’s ways of thinking, captured through the final card sort interview

Arun

Simon
Emma
Appendix 7.9 – Drawing coding systems together

When I began the process of bringing together the different analyses of teacher interview data I used the ways of thinking labels as a starting point. Initially I looked for similarities between the teachers’ ways of thinking (marked yellow below). It was clear that there were many exact matches and also other labels that could be easily combined, for example ‘sharing to find something new’ could be matched with ‘spreading knowledge’ and ‘freedom to share ideas’ could be matched with ‘getting ideas outside’.

Table A7.9a: Ways of thinking marked to show similarities and differences

<table>
<thead>
<tr>
<th>Simon Ways of thinking - In order of relative occurrence</th>
<th>Emma Ways of thinking - In order of relative occurrence</th>
<th>Arun Ways of thinking - In order of relative occurrence</th>
</tr>
</thead>
<tbody>
<tr>
<td>Being scientific</td>
<td>Sharing to find something new</td>
<td>Spreading Knowledge</td>
</tr>
<tr>
<td>Getting ideas outside</td>
<td>Control</td>
<td>Safety</td>
</tr>
<tr>
<td>Independence</td>
<td>Safety</td>
<td>Freedom to explore ideas</td>
</tr>
<tr>
<td>Assessment for Learning</td>
<td>Assessment for Learning</td>
<td>Being scientific</td>
</tr>
<tr>
<td>Developing understanding</td>
<td>Accountability</td>
<td>Progression of strategies</td>
</tr>
<tr>
<td>Control</td>
<td>Developing understanding</td>
<td>Environment and culture</td>
</tr>
<tr>
<td>Engagement</td>
<td>Engagement</td>
<td>Challenge and questioning</td>
</tr>
<tr>
<td>Consolidation and consensus</td>
<td>Feeder strategy</td>
<td>Assessment for Learning</td>
</tr>
<tr>
<td>Accountability</td>
<td>Challenging and questioning</td>
<td>Concrete knowledge rehearsal</td>
</tr>
<tr>
<td>Communication skills</td>
<td>Time</td>
<td>Control</td>
</tr>
<tr>
<td>Challenge</td>
<td>Participation</td>
<td>Communication skills</td>
</tr>
<tr>
<td>Explanation</td>
<td>Independence</td>
<td>Engagement</td>
</tr>
<tr>
<td>Planning</td>
<td>Importance of different perspective</td>
<td>Planning</td>
</tr>
<tr>
<td>Resistance from pupils</td>
<td>Communication skills</td>
<td>Putting ideas together</td>
</tr>
<tr>
<td></td>
<td>collaboration</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Answering questions</td>
<td>Participation and collaboration</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Clarification and consolidation</td>
<td>Feeder strategy</td>
</tr>
</tbody>
</table>

There were a small number of categories that appeared with only one of the participants (marked blue) and then a set of others remaining (marked green). What was very clear was that these seemed to be encompassed by the idea of developing understanding; they were
labels given where teachers had been considering the skills of reasoning and argumentation for developing scientific knowledge and in fact many of the labels corresponded (if not exactly in the wording) with the features of Exploratory Talk (Mercer, 1995). I saw this final set of labels as perhaps a category for the language of learning; it incorporates themes of how talk is used as a tool in the process of developing understanding from simply spreading knowledge by sharing and cumulating ideas to questioning, challenging, sharing, explaining and consolidating. In constructing the subsequent belief map, I tried to make this explicit by drawing it out as a separate sub theme within the pedagogic category.

In working through this process of amalgamation, it became possible to draw all the ideas together and combine them but still ensure the representation was authentic to the individual teachers. At this point I also added into the picture the ways of thinking that had been drawn out through the initial elicitation interview but that were not present at the end. I did this in order to collect together a complete picture of the network of ways of thinking that appeared to be drawn upon by the participating teachers, when they considered the use of group discussion in their science lessons. Of course what this representation doesn’t show is the relative occurrence of the variety of ways of thinking but the purpose initially was to create a map of espoused teacher thinking so that the complexity could begin to be captured. This map is shown in Figure A7.9a.
The next stage of the process was to see if the earlier thematic analysis of the teacher semi structured interviews fitted with this picture, despite its differing starting point. In fact, although named slightly differently in places, it was not a difficult task to see how these nodes fitted very well with the picture under construction. However, there were some ideas which emerged during the analysis of the semi structured interviews which had not done so during the elicitation activity, such as ‘children understanding talk for their learning’ and a number of ideas about ‘being scientific’ such as inquiry, creativity and the nature of science. These were incorporated onto the map as new themes or subthemes, along with a separate node which was built to capture the times when teachers were explicitly reflecting upon the changing nature of their practice. The node of ‘balancing with the whole class’ was combined with ‘feeder strategy’ which was already in place. This collapsing of themes can be useful when there is not too much data to support them as separate entities (Braun and Clarke, 2006) as long as the data is being brought together in a coherent way. Upon consultation of the one textual reference for ‘dynamic decision making’ I decided it was appropriate to combine this with ‘teacher thinking about practice’ and in addition ownership, independence and freedom were also collapsed into one node. Through this
whole process, a ‘master’ code structure based upon the entire teacher interview data was created which should provide an ‘organising principle’ or ‘illustrative tool’ in the interpretation of the data (Attride-Stirling, 2001) and the review and exploration of themes. This map is shown in Figure A7.9b.

Figure A7.9b: Ways of thinking map created from all interview data

A new folder was then created in Nvivo with this map as the basis for a node tree. The existing coding references for all of the interviews were reorganised into this new system and oral diary and observation data were analysed using this coding system. During this process it became necessary to add further nodes to the tree and make some amendments. For example, interpretative nodes were added to the tensions area, talk as a tool was relabelled as ‘Cognitive’ and I decided to pull out ‘Scientific’ as a separate category due to the amount of items being coded to it; this seemed to give this area further status. The final coding structure can be represented in tabular form as follows:
### Table A7.9b: Master coding structure of teacher ways of thinking from all interview data

<table>
<thead>
<tr>
<th>Organising Theme</th>
<th>Basic Theme</th>
<th>Number of Coding References</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cognitive</td>
<td>Developing understanding</td>
<td>73</td>
</tr>
<tr>
<td></td>
<td>Sharing Ideas</td>
<td>149</td>
</tr>
<tr>
<td></td>
<td>Metacognition</td>
<td>16</td>
</tr>
<tr>
<td></td>
<td>Justifying</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Explaining</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>Using vocabulary</td>
<td>12</td>
</tr>
<tr>
<td></td>
<td>Consolidation</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Consensus</td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>Clarification</td>
<td>4</td>
</tr>
<tr>
<td></td>
<td>Challenging</td>
<td>90</td>
</tr>
<tr>
<td></td>
<td>Questions</td>
<td>8</td>
</tr>
<tr>
<td>Tensional</td>
<td>Time</td>
<td>23</td>
</tr>
<tr>
<td></td>
<td>Balancing social/cognitive</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Requiring conceptual consensus</td>
<td>13</td>
</tr>
<tr>
<td></td>
<td>Pupil resistance</td>
<td>36</td>
</tr>
<tr>
<td></td>
<td>Control and security</td>
<td>128</td>
</tr>
<tr>
<td></td>
<td>Consolidating (Mis)conceptions</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td>Balancing sharing/ developing understanding</td>
<td>43</td>
</tr>
<tr>
<td></td>
<td>Accountability</td>
<td>19</td>
</tr>
<tr>
<td>Pedagogic</td>
<td>Task facilitation - preparation for writing</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>Task facilitation – planning for practical</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Vocabulary</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td>Progression of strategies and sequence</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Modelling talk</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Feeder strategy for whole class work</td>
<td>34</td>
</tr>
<tr>
<td></td>
<td>Resources</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>General communication skill</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Assessment for Learning/airing misconceptions</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>SK</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>Teacher role and input to group</td>
<td>21</td>
</tr>
<tr>
<td>Social</td>
<td>Valuing ideas</td>
<td>11</td>
</tr>
<tr>
<td></td>
<td>Pupil safety</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Involvement/Participation</td>
<td>47</td>
</tr>
<tr>
<td></td>
<td>Inclusion</td>
<td>17</td>
</tr>
<tr>
<td></td>
<td>Engagement</td>
<td>41</td>
</tr>
<tr>
<td></td>
<td>Culture and environment</td>
<td>40</td>
</tr>
<tr>
<td></td>
<td>Confidence</td>
<td>7</td>
</tr>
<tr>
<td></td>
<td>Collaboration</td>
<td>45</td>
</tr>
<tr>
<td></td>
<td>Independence and ownership</td>
<td>71</td>
</tr>
<tr>
<td>Scientific</td>
<td>Scientific inquiry</td>
<td>98</td>
</tr>
<tr>
<td></td>
<td>Nature of Science</td>
<td>44</td>
</tr>
<tr>
<td></td>
<td>Creativity</td>
<td>25</td>
</tr>
<tr>
<td>Teacher</td>
<td>Valuing talk</td>
<td>24</td>
</tr>
<tr>
<td>General</td>
<td>Uses for talk</td>
<td>33</td>
</tr>
<tr>
<td>Reflection</td>
<td>Teaching Science</td>
<td>14</td>
</tr>
<tr>
<td></td>
<td>Teacher thinking about changing practice</td>
<td>35</td>
</tr>
</tbody>
</table>
Figure A7.9c: Master map of teacher ways of thinking from all interview data
## Appendix 7.10 - Coding the pupils' interviews

<table>
<thead>
<tr>
<th>Activity</th>
<th>Being Scientific</th>
<th>Pupil Ownership</th>
<th>Resistance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Enquiry</td>
<td>Not</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Questioning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Collaboration</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Teacher input to group</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Involvement &amp; Explanation</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solving problems</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Consensus</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Valuing ideas</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Justified reasoning</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Engagement</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Not with Time</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Nodes compared by number of coding references

- **Sharing ideas**
- **Developing understanding**
- **Whole class input**
- **Challenge**
- **Helping each other**
Appendix 7.11– Grouping the pupils’ ways of thinking
### Appendix 7.12 Final interview broad thematic overview

<table>
<thead>
<tr>
<th>Social environment for talk</th>
<th>Group talk developing science as inquiry</th>
<th>Group talk as a tool</th>
</tr>
</thead>
</table>
| - Non-threatening environment is important for inclusion of all  
- Culture of talk and collaboration in the classroom  
- Develop the use of talk across the curriculum; encourage children to have confidence in using talk, question and challenge;  
- Provide a secure environment  
- Expectation of children using talk and contributing - be interested in their talk  
- Group dynamics are important – for inclusion, challenge and knowledge sharing; listening and reflecting is vital  
- Modelling discussion; having expectations of the group talk  
- Setting up the task so it’s accessible for all – start with their wondering  
- Children appreciating the talk – if not quite realising the potential of it  
- Children active and independent; discussion natural not forced rules/roles  
- Ensuring children are secure with sharing ideas | - Focus on science as a process (enquiry fore fronted ) and the importance of scientific thinking over correct concrete knowledge acquisition; importance of teacher seeing these goals  
- Children asking questions themselves  
- Children allowed to wonder – this can be difficult with abstract areas of science  
- Talking is working like a scientist; collaborating, problem solving and sharing  
- Setting a challenge for the group discussion  
- Importance of asking questions/basing talk around questions  
- Importance of basing talk tasks around practical work/problem solving so children experience science – provides focus for talk but also opportunity to come up with conclusions – are able to focus on process not just knowledge  
- Science group discussions need to be based on children talking about process  
- Questioning, justification, reasoning, explanation and conclusion | - Group talk is important - a tool for more natural assessment  
- Heightened value of group talk; creates interest, participation, focus and engagement  
- Talk for inclusion, challenge and knowledge sharing; listening and reflecting is vital  
- Developing critical thinking skills  
- Challenge of extending thinking  
- Talk as a way of getting from one point to another - on a journey |
| Pedagogy of using group talk | • Fine tune the use of group talk – find a balance with whole class talk  
• Need flexibility in planning - gives rise to a dynamic use of group talk; follow children’s lead but have a goal in mind; keep the flow moving weaving through group and whole class  
• Teacher as overseeing, facilitating and allowing the challenge of the task to lead the children  
• Importance of whole class forum for reporting/reflecting  
• Sharing of information is just part of the journey - challenge lies in the review and reflect – bringing the learning together – how can children be encouraged to do this independently  
• Teacher questions initiating talk but follow the children’s ideas |
| --- | --- |
| Group talk for ownership of understanding | • Teacher standing back; letting pupils ‘have their heads’; less controlled direction  
• Pupils take ownership and responsibility; become empowered; children lead their own learning; take charge, invest more  
• Children asking questions themselves; groups self-generate thinking, become independent and in doing so address their own misconceptions  
• Give pupils control; don’t always interfere. But this takes teacher confidence and clear knowledge of planning.  
• Keep them alive with practical, making their own plans and decisions.  
• Allowing children more time for talk in groups through activity but ensure children make their own decisions on how to carry it out  
• Creating opportunities for talk without teacher involvement  
• Trusting children to focus on the learning activity  
• Forefront children working on their own ideas  
• Children being involved and taking ownership through practical talk task; the true learning is there in the experience- in children questioning themselves  
• Children taking pride in ownership; gaining confidence and satisfaction  
  Setting up situations for challenging/ extending each other |
| Tensions in using group talk | • Giving pupils time for talk; not rushing. Talk strategies are important but sometimes there is not enough time  
• Allowing the freedom to talk but this can create space for consolidation of misconceptions; careful timing of teacher input  
• Talk is important but so is getting evidence for accountability; getting ideas recorded; knowing an ‘outcome’ is needed as proof but trying to move away from writing everything down  
• Allowing pupils freedom to explore through group discussion; bring together to gain consensus/conclusion  
• Challenge to ensure that pupils have all learned the science that you needed and have an understanding of what has taken place  
• Teacher involvement; allowing children independence but knowing when to step in to keep things on track, ask key question  
• Ensuring all on task |
Appendix 8 – Lesson summaries

Appendix 8.1 Example of lesson and peer group talk activity summary
See Appendix 9.3 and Table A9.3d for origin of ‘Talk Purpose’ column entries

<table>
<thead>
<tr>
<th>Arun</th>
<th>Scientific Topic</th>
<th>Peer Group Talk Activity</th>
<th>Talk Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson 1</td>
<td><em>L.O. To know how a bulb is affected by changes to a circuit</em></td>
<td>Talk partners - discuss what they already know.</td>
<td>Share ideas, evaluate and come to a consensus</td>
</tr>
<tr>
<td>9th Oct</td>
<td>Challenge set – how can you make the bulb brighter? Tells children what a fair test is. Models completing a planning sheet. Ideas about fair testing discussed as a class. Groups plan and conduct investigation. Class review of how fair test was made/what conclusions were made.</td>
<td>Concept Cartoon for group discussion; envoy from each group goes to another group to report on their ideas and share. Groups given time to discuss plans and record on the sheet and encouraged to conclude from the results.</td>
<td>Plan inquiry procedure Discuss evidence from inquiry and draw conclusions Carry out practical inquiry work</td>
</tr>
<tr>
<td>Lesson 2</td>
<td><em>L.O. Investigate shadow formation</em></td>
<td>Thought shower on what they know about light and shadow; envoy again has to prepare to go to other group and present thinking. Talk partners discuss shadows. Group discussion on equipment to investigate shadows. Children explore shadows; asked to work together and discuss findings.</td>
<td>Share ideas, evaluate and come to a consensus Plan inquiry procedure Discuss evidence from inquiry and draw conclusions Carry out practical inquiry work Make predictions</td>
</tr>
<tr>
<td>Nov 13th</td>
<td>After thought shower on light and shadow, Arun brings all class to carpet and asks question about shadows, takes feedback and some modelling of shadow position is carried out on IWB. Children asked to explore shadows made by range of materials and record findings.</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Appendix 8.2 Example of lesson by lesson data summary

<table>
<thead>
<tr>
<th>Arun</th>
<th>Topic</th>
<th>Notes</th>
<th>Oral diary notes</th>
<th>Pupils’ ideas</th>
</tr>
</thead>
</table>
| Lesson 1 | To know | LO/reminder of ground rules for group work and using reasoned argument; Concept Cartoon given – talk for 5 mins. Teacher (T) works with specific groups directing them with questioning. | Non-threatening environment; keep it simple, easy to use strategies. | Value practica  
|       | how a bulb is affected by changes to a circuit | Envoy from each group goes to another group to report on their ideas and share. Each group asked to present ideas to the class. T summarises and reformulates at points adding vocabulary in places; also asks children to give reasons - in turn with each group. Children called to the whole class and reminded about listening. Given very short time in talk partners to discuss what they already know. T works with a pair. T then takes feedback from a range of pupils; pulls out topic vocabulary. T then gives a question for talk partners to consider – follows this with feedback. T sets a challenge – how can you make the bulb brighter? Tells children what a fair test is and models completing the planning sheet. Groups given time to plan on the sheets – some struggle to understand procedure. Class discussion over what they are all doing – do they all know how to make it fair? Range of ideas from around the room considered. Groups work independently, sometimes moving around to see what others are doing. T moves between groups, providing further equipment where necessary. T asks groups to sum up how they have made their test fair as he goes round groups. Whole class forum to review each group’s ideas – changed/found out. T summarises; adds vocabulary in places. Review of conclusion and cartoon reflection. | Children shared ideas but had hoped for more positive challenge – children need more confidence in this. Organisation/logistics/timing is tricky. Children need leading to ‘correct way of thinking’; need directing when talking. | I work Sharing ideas Need mix of w/c and group Like being challenged ged but also given hints |
## Appendix 8.3 Summary of learning objectives for all observed lessons

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Emma’s Learning Objective</th>
<th>Arun’s Learning Objective</th>
<th>Simon’s Learning Objective</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Know how changes affect a food chain</td>
<td>To know how a bulb is affected by changes to a circuit</td>
<td>Planning a fair test</td>
</tr>
<tr>
<td>2</td>
<td>To know the structure of human skeleton</td>
<td>Investigate shadow formation</td>
<td>Making a food web</td>
</tr>
<tr>
<td>3</td>
<td>To plan a fair test</td>
<td>To investigate different materials and the shadows they form</td>
<td>Testing how shadows change</td>
</tr>
<tr>
<td>4</td>
<td>To plan and carry out a fair test</td>
<td>To investigate friction from different surfaces</td>
<td>light travels differently through different materials</td>
</tr>
<tr>
<td>5</td>
<td>To carry out a fair test around thermal insulators</td>
<td>To identify natural and manmade materials</td>
<td>How do we protect the environment?</td>
</tr>
<tr>
<td>6</td>
<td>Some solids can be compressed but retain their weight</td>
<td>To plan and carry out an absorbency fair test</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>Ta ask questions about dissolving</td>
<td>To know what plants need to group</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>To know how surfaces affect friction</td>
<td>To explore how temperature affects plant growth</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td></td>
<td>To identify different food groups and their purposes</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 9 – Analysis of peer group talk

Appendix 9.1 – Example of broad summary grid of peer group talk

<table>
<thead>
<tr>
<th>Lesson</th>
<th>Arun</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Some features shown – mainly procedural (including the Q and challenge) one off event with challenge, elaboration and repetition; no reasoning, justification or hypothesising.</td>
</tr>
<tr>
<td>2</td>
<td>Some long episodes with features when children are sharing ideas – they attempt to explain and elaborate; one concept is grappled with (how fire is natural and starts by itself) and threads through the transcription.</td>
</tr>
<tr>
<td>3</td>
<td>Extended dialogue on what translucent means – lots of features but the children continue to struggle with this idea, going round in circles until another group adds their thoughts; as they test their ideas with materials there is some clarity but still confusion from some – perhaps the decision they came to earlier when they were asked to have a consensus is challenged by testing and this confuses? Should testing and discussing be combined?</td>
</tr>
<tr>
<td>4</td>
<td>A lot of procedural dialogue; some exploration of fair testing in one short episode and also when making predictions; almost all of the rest is a commentary on what is happening and what the group are doing/doing next.</td>
</tr>
<tr>
<td>5</td>
<td>A lot of sharing ideas – when they are defining things and sharing knowledge of materials. They actually only really attack the question of natural/manmade and how it is made. Children accumulate each other’s stories into the shared space – where they don’t know e.g. rigid – they need input; teacher senses this and intervenes. After they have been outside the group work is used as a space to just share what they found.</td>
</tr>
<tr>
<td>6</td>
<td>When predicting some attempts to justify but not fully reasoned; challenges evident; when planning fair test, features found – justification not until the teacher asks a question though; continues with a lot of procedural talk – some questioning; less discussion over the concept of absorbency</td>
</tr>
<tr>
<td>---</td>
<td>---</td>
</tr>
<tr>
<td>7</td>
<td>Children discuss the 6 questions in turn – adding and creating strings of ideas. Very little questioning – a lot of adding on. At points a child clarifies where they have got to with a summative statement so far; collection of related ideas rather than developing an idea tightly; children have been encouraged to ask questions but they lack focus; when teacher asks for discussion on what plants need we see one hypothetical idea and one attempt at justification. Also a lot of talk of whose turn it was.</td>
</tr>
<tr>
<td>8</td>
<td>Features evident in episode where children have to make decision about where to grow plants – they have to explain and give reasons. Adult offers the question at a key point though not child. When children make decisions about which plant grows where – there is a lot of fighting over who does which food until adult intervenes and reminds of ground rules. They are unable to challenge strongly or discuss - becomes a layering of fact; explanations and challenges evident when discussing the fair test.</td>
</tr>
<tr>
<td>9</td>
<td>Again a layering of ideas when the children discuss diet – they all agree. When they decide on groups for food – some challenging evident and some questioning; again later, questioning and justifications evident.</td>
</tr>
</tbody>
</table>
### Appendix 9.2 Analytical tool – features of Exploratory Talk

<table>
<thead>
<tr>
<th>Feature of peer group talk</th>
<th>Symbol noted on transcript during analysis</th>
</tr>
</thead>
<tbody>
<tr>
<td>Confirmations</td>
<td>Con</td>
</tr>
<tr>
<td>Assertion of knowledge</td>
<td>K</td>
</tr>
<tr>
<td>Question</td>
<td>Q</td>
</tr>
<tr>
<td>Explanation - procedural</td>
<td>EX -P</td>
</tr>
<tr>
<td>Explanation - conceptual</td>
<td>EX -C</td>
</tr>
<tr>
<td>Recount of another’s idea/repetition</td>
<td>Rep</td>
</tr>
<tr>
<td>Reformulation of another’s idea</td>
<td>Ref</td>
</tr>
<tr>
<td>Clarification</td>
<td>Cl</td>
</tr>
<tr>
<td>Elaboration</td>
<td>El</td>
</tr>
<tr>
<td>Contrasting idea given/challenge</td>
<td>C</td>
</tr>
<tr>
<td>Hypothetical question</td>
<td>HQ</td>
</tr>
<tr>
<td>Consensus stated</td>
<td>Con</td>
</tr>
<tr>
<td>Scientific vocabulary</td>
<td>Voc</td>
</tr>
<tr>
<td>Teacher intervention</td>
<td>TI</td>
</tr>
<tr>
<td>Request for clarification</td>
<td>R</td>
</tr>
<tr>
<td>Justification of idea</td>
<td>J</td>
</tr>
</tbody>
</table>
Appendix 9.3 Quantitative Analysis of Peer Group Talk

Computer based word search and counting tools were used with the peer group activity transcripts taken from all three classrooms across the year. Relative incidence of key words and phrases associated with Exploratory Talk were searched. These words were ‘if’, ‘because/’cos’, ‘I think’, ‘I agree/disagree’, ‘so’, ‘although’ and ‘however’ (Mercer, 2004). Where words were found within the data but had been used in a dispute, I did not count them. For example one transcript in Arun’s set contained the use of the word ‘because’ but it was being used in an argument over who’s turn it was next. In this case the incidence of ‘because’ where pupils were justifying their point is not included in the count as it could not be deemed to be a measure of the use of the word in relevant learning dialogue. In addition, one of the children in Arun’s class focus group had a tendency to use the word ‘so’ a lot as a turn of phrase therefore I had to look carefully at the relevance of the term when it came up in the search before including it in the count.

Quantitative analysis of the group discussion transcripts such as that presented below, does have limitations. The context and detail is lost by looking at the data in this way, although the qualitative phase of the methodology restores this. Because the key words were not specifically taught to the groups in this study the measurement of them in the analysis is perhaps not tightly relevant, however their occurrence still provides a useful indicator of the presence of Exploratory Talk. The results of the quantitative analysis are given in the tables A9.3a, A9.3b and A9.3c.
Table A9.3a: Overall quantitative discourse analysis of Emma’s lessons. *For this lesson which was long, the peer group was broken into two for their work so both were recorded. These two factors can partly account for this particularly high number of key words. When broken down into the two groups the results are still of note – Table A9.3a(i).

<table>
<thead>
<tr>
<th>Key word</th>
<th>Group A</th>
<th>Group B</th>
</tr>
</thead>
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<td>Think</td>
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<td>10</td>
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<tr>
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<tr>
<td>However</td>
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Table A9.3a(i) – quantitative analysis of Emma lesson 5 divided into the 2 peer groups

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<tr>
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<th>Emma Lesson 4</th>
<th>Emma Lesson 5*</th>
<th>Emma Lesson 6</th>
<th>Emma Lesson 7</th>
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<tbody>
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<td>23</td>
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<tr>
<td>8.5 minutes talking</td>
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<td>14.75</td>
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</tr>
<tr>
<td>Because/’cos</td>
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<td>Think</td>
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<tr>
<td>Agree/disagree</td>
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<td>5</td>
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<td>So</td>
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<tr>
<td>Although</td>
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<td>However</td>
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Table A9.3b: Overall quantitative discourse analysis of Arun’s lessons

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<th>Arun Lesson 4</th>
<th>Arun Lesson 5</th>
<th>Arun Lesson 6</th>
<th>Arun Lesson 7</th>
<th>Arun Lesson 8</th>
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<tbody>
<tr>
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<td>20 mins talking</td>
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<td>19.5 mins talking</td>
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<td>8</td>
<td>2</td>
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<td>Because/’cos</td>
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<td>19</td>
<td>6</td>
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<td>44</td>
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### Table A9.3c: Overall quantitative discourse analysis of Simon’s lessons

<table>
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<th>Simon Lesson 1</th>
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<th>Simon Lesson 3</th>
<th>Simon Lesson 4</th>
<th>Simon Lesson 5</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Amount of time groups given to talk</strong></td>
<td>28 minutes talking</td>
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<td>28.5 minutes talking</td>
<td>32.5 minutes talking</td>
<td>11 minutes talking</td>
</tr>
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</tr>
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<td>26</td>
<td>34</td>
<td>13</td>
</tr>
</tbody>
</table>
These tables show that children utilised different amounts of key words in different lessons and that at times, children seemingly talk in more exploratory ways than others. Some lessons are significantly more or less productive than others. This perhaps rather crude initial analysis is broadly congruent with the brief descriptive analysis carried out at the stage of transcription as previously mentioned (Appendix 9.1). However, from this it was also clear that within each lesson’s collaborative activity and discussion there were pockets of talk of real interest; sequences which demonstrate that children were working and thinking in productive and exploratory ways but also that there were periods where children were talking off task or in more cumulative or disputational ways. Therefore, in order to pinpoint more clearly where the productive talk occurred, it seemed appropriate to divide the lessons into episodes using lesson observation notes and group talk transcripts as guides. These episodes were created by identifying segments of lessons, for example where the teacher had created breaks or had set different tasks for children to do or seemed to be using talk for different purposes. From the twenty two lessons a total of fifty four episodes were identified. The range of uses for group talk identified through this process is given in Table 9.3d. Appendix 8.1 holds example lesson overview with talk purpose assigned.

**Table A9.3d: Range of Talk Purposes**

<table>
<thead>
<tr>
<th>Range of Talk Purposes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. share ideas, evaluate and come to a consensus</td>
</tr>
<tr>
<td>2. plan inquiry procedure</td>
</tr>
<tr>
<td>3. discuss evidence from inquiry and drawing conclusions</td>
</tr>
<tr>
<td>4. review prior learning to re-establish points</td>
</tr>
<tr>
<td>5. formulate questions for inquiry</td>
</tr>
<tr>
<td>6. generate ideas</td>
</tr>
<tr>
<td>7. make predictions</td>
</tr>
<tr>
<td>8. carry out practical inquiry work</td>
</tr>
<tr>
<td>9. consider inquiry process</td>
</tr>
<tr>
<td>10. hypothesise</td>
</tr>
<tr>
<td>11. for cohesion/lesson structuring</td>
</tr>
<tr>
<td>12. apply new ideas</td>
</tr>
<tr>
<td>13. complete a written activity</td>
</tr>
<tr>
<td>14. solve a problem</td>
</tr>
</tbody>
</table>

Quantitative analysis was then repeated with the transcripts in order to show the distribution of key words within the episodes and the results shown in the Tables A9.3e, A9.3f and A9.3g.
Table A9.3e: Quantitative discourse analysis by episode - Emma

<table>
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<th>Lessons</th>
<th>1</th>
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<th>3</th>
<th>4</th>
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Table A9.3f: Quantitative discourse analysis by episode - Arun

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<td>1.12</td>
</tr>
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</table>
Connecting with different purposes for talk

Sometimes peer group discussion activities covered a range of uses, as can be seen from the quantitative analysis by episode grids (A9.3e, A9.3f and A9.3g). For example in Emma Lesson 5 (Table A9.3e) talk is used for groups to consider ideas and come to a reasoned consensus, to plan an inquiry, carry it out and consider the evidence when making conclusions. Some talk purposes were frequently used during the project, such as sharing ideas, evaluating and coming to a consensus, planning inquiry procedure and carrying out practical inquiry. Not all of the talk purposes were drawn upon by all teachers. For example, only Simon used it as the lead in to a writing activity and only Arun used it as a lesson structuring device when he asked a group to share what they had just worked on together outside as soon as they returned back to their classroom tables.

Linking these two different sets of analyses (Table A9.3h) it is possible to see that when the high frequency of key vocabulary associated with Exploratory Talk is occurring, the teachers are drawing on a reduced range of purposes for talk and in particular when they are requiring children to share ideas, evaluate them and come up with a consensus (Table A9.3i).
Table A9.3h: Productive Exploratory Talk episodes and the associated talk purpose

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<th></th>
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<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Episode</strong></td>
<td><strong>Lesson 2 Episode 1 and 2</strong></td>
<td><strong>Lesson 3 Episode 1 and 2</strong></td>
<td><strong>Lesson 4 Episode 1</strong></td>
<td><strong>Lesson 5</strong></td>
<td><strong>Lesson 6 Episode 2</strong></td>
<td><strong>Lesson 8 Episode 3</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Talk Purpose</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus</strong></td>
<td><strong>Planning inquiry procedure Consider inquiry process</strong></td>
<td><strong>Making predictions Hypothesise</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus Making predictions Carrying out practical inquiry</strong></td>
<td><strong>Discussing evidence from inquiry and drawing conclusions Carrying out practical inquiry</strong></td>
<td><strong>Discussing evidence from inquiry and drawing conclusions Carrying out practical inquiry</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus</strong></td>
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</table>

<table>
<thead>
<tr>
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<td><strong>Episode</strong></td>
<td><strong>Lesson 1 Episode 1 and 3</strong></td>
<td><strong>Lesson 2 Episode 1</strong></td>
<td><strong>Lesson 3 Episode 2</strong></td>
<td><strong>Lesson 6 Episode 2</strong></td>
<td><strong>Lesson 8 Episode 1 and 3</strong></td>
<td><strong>Lesson 9 Episode 2 and 4</strong></td>
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<td><strong>Talk Purpose</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus Discussing evidence from inquiry and drawing conclusions Carrying out practical inquiry</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus Applying ideas</strong></td>
<td><strong>Planning inquiry procedure</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus Sharing ideas to come to a consensus Consider inquiry process</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus</strong></td>
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<td><strong>Talk Purpose</strong></td>
<td><strong>Formulating questions for inquiry</strong></td>
<td><strong>Carrying out practical inquiry Hypothesise; To solve a problem</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus</strong></td>
<td><strong>Planning inquiry procedure</strong></td>
<td><strong>Carrying out practical inquiry Making predictions Carrying out practical inquiry</strong></td>
<td><strong>Discussing evidence from inquiry and drawing conclusions Carrying out practical inquiry</strong></td>
<td><strong>Share and evaluate ideas to come to a consensus</strong></td>
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The data show that talk was used for different purposes by the teachers and that pupils engage in peer group dialogue differently at different times. What is interesting is that the more productive group discussions apparently punctuate the year – there is no smooth progression in the emergence of Exploratory Talk over time. In contrast, it seems that the success of group talk is episodic and infrequent.
Appendix 9.4 Disputational Talk
This kind of talk was heard throughout the project. One example of this was in a lesson through which Simon aimed to help children understand how shadows change as the light source changes. The groups were asked to plan and carry out an investigation. After creating their inquiry question and planning how they may work practically to answer it, the teacher asked the groups to consider their predictions:

Extract 1: Making predictions
Tom: right what are we going to put as our prediction first
Andrew: I can’t see anything
Mark: right I don’t think that’s going to be true
Tom: yes or no
Mark: I actually think no
Ella: I think yes
Andrew: you are allowed to put yes and no
Ella: yes
Andrew: I can’t see a thing I can’t see a thing prediction
Mark: it will
Andrew: done. I think yes
Ella: I think yes my prediction is yes
Andrew: my prediction it would work it won’t work I predict it won’t work
Tom: you’ll have to be change or no change
Andrew: no shadow
Ella: yes
Andrew: no

Through this short extract it is possible to see that, despite Tom’s best efforts to organise the group into joint activity at the start, the others engage in the statement and restatement of their own ideas and there is no collaborative outcome from this sequence. There is no questioning of each other as to why they may have a particular idea and there is no justification of thinking from any member. The outcome here is that each child takes away their own original idea, untouched at this point by others’ contributions.
Appendix 9.5 Cumulative Talk

Very often the talk task set by the teacher required children to share ideas and this is an important tool for a constructivist approach to learning and teaching where constructing new ideas is seen to depend upon existing knowledge (Fensham, Gunstone and White, 1994). The discourse that emerged during these tasks was generally of an agreeable and collaborative nature with children layering ideas, sometimes using justification, elaborating upon each other’s contributions and drawing on scientific vocabulary. There were many different occasions throughout the year in all of the classrooms when the groups worked in this non-challenging way, coming to agreement but showing little dynamic thinking, demonstrating that group members were not engaged in deep consideration or rethinking of ideas. A large amount of the talk occurring in the groups was of this variety but I will only briefly present example extracts. The context of this next extract is Emma’s lesson 4, planned to help children explore how water temperature changes over time. Just prior to this discussion the children had been asked to think about how they could test their ideas about temperature changes:

Extract 2: Ideas for testing
Harry: we’re gonna keep it for like erm until tomorrow
Ellie: get a cup and put some water in a keep it in here and see what see and then see
Harry: and then we’ll check tomorrow
Nathan: see what happens
Ellie: see what changes
Ali: yea see what happens
Ellie: and see what’s changed

It can be seen how the children move toward the consensus by adding their individual ideas into the public forum. Beginning with Harry’s idea, which Ellie elaborates with some specifics, each idea is accepted by the group until they have co-constructed the bare bones of a plan for their investigation. Each contribution creates a layer which is built upon by the next person. The talk is collaborative and the group produce a workable outcome but there is no evidence of developing thinking, through any
challenge, questioning or justification. Ellie’s contribution after Nathan could be interpreted as a challenge perhaps but upon listening to the recording, the intonation used does not suggest that this is her intention. This extract is taken from an episode where the children are talking about a practical procedure but this kind of talk also emerged when children were talking about abstract concepts.

In Extract 3, Arun’s children are discussing the content of a Concept Cartoon, the purpose of which is to generate discussion and foster challenge and positive conflict in children’s dialogue (Keogh and Naylor, 1999). The particular cartoon being considered in this extract requires the children to consider a range of possible ways of thinking about what effect varying the components in a circuit will have on the light bulb:

**Extract 3: Circuits**

*Lucy: Nigel with wires wires it doesn’t really matter*

*Oliver: it doesn’t matter*

*Lucy: it carries energy to the bulb*

*Oliver: no matter how thick it is or how thin it is it*

*Lucy: it doesn’t matter how long it is it doesn’t matter how short it is*

*Beth: you just need a wire to*

*Lucy: you just need a wire*

*Beth: yea*

*Nigel: yea because*

*Lucy: or a few wires*

*Nigel: a thick wire  It doesn’t really matter if it’s thick or thin it still going to take it*

*Oliver: the electricity will go the same through because the battery has got the same power as the thin and thick one the same amount of electricity will just go through it the same*

*Nigel: It doesn’t matter does it  it doesn’t matter*

*Lucy: no*

*Nigel: it doesn’t matter does it*

*Beth: so it’s just the third one the third one is right  correct*
It can be seen how during this sequence, the children engage in an agreeable exchange, with Oliver even providing a justification at one point but the sequence is characterised by statements, reinforcements and elaborations. It is interesting to note how the group appropriate each other’s language with a number of the children using the phrase ‘it doesn’t matter’, perhaps to reinforce the point. The group arrive at a consensus, however this was perhaps present from the outset and the talk functioned as an accumulation or parade of knowledge (Solomon, 1993). Once again no challenge or deep consideration of thinking is evident and the children seem happy with their ideas as they are, they appear not to see any need to challenge or question, they are content to consolidate their current thinking. Cumulative talk such as this, whilst being collaborative and pleasant, holds little potential for conceptual development and if children are content with their ideas they are unlikely to reconstruct them into something new.

Cumulative type talk was also heard when children were engaged in practical work that was designed to provide opportunities to notice new phenomena. For example in one of Simon’s lessons where the aim was for children to know that water affects how we see things, children were asked if they could make a pencil bend:

**Extract 4: Bending pencils**
*Tom: we’ve done it, we’ve done it, we’ve bent the pencil*

*Mark: that is generally bent*

*Evan: that is just weird*

*Mark: we’ve done it*

*Ella: can you do it with my finger*

*Tom: that is not bent*

*Ella: yea my finger has gone thin*

*Tom: it’s not bent*

*Ella: it looks bent though*

*Tom: it looks like it’s bent but it’s not*

*Mark: oh no it’s not if you look hard enough*

*Evan: it’s cut in half*

*Ella: it’s cool though*
Mark: we’ve cut it in half
Evan: we’ve cut a pencil in half
Ella: it’s wonky

In this extract, the children are using their talk as a tool for making their observations explicit. The talk helps the group to verbalise what they are noticing. As they help each other notice things through their talk, their observations constitute a more fully developed picture than perhaps the group would have done as individuals.

During Arun’s lesson 4 episode 2, pupils were asked to plan how they may carry out a fair test which would help them investigate how friction varied according to the surface material. The children had spent a few minutes prior to this extract discussing their plan and what materials they may need and Lucy had brought the discussion together with ‘put the weights in one of those pots and then get the force meter and pull it across the floor’. In the first part of the following extract, a few features of exploratory talk can be seen as the children work to help one member of the group think about fair testing in a different way but then the talk moves almost immediately onto displaying more cumulative qualities:

**Extract 5: Fair testing**
Lucy: Nigel what is next
Nigel: how will we make it a fair test
Lucy: how will we make it a fair test make sure everyone has a go
Oliver: and make sure the same amount of weights as well
Beth: no keep the weights the same
Oliver: yea
Lucy: but then it will be the same all the time
Oliver: otherwise it won’t be a fair test say if you pull it across here and it takes 5N and you take one out and it says it takes like 1N it’s not a fair test
Lucy: look look Nigel do you think this is correct or stupid Oliver says we should always pull the same amount of weights
Nigel: yes that’s a fair test
Lucy: but then it will be the same always
Oliver: fully

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Nigel: no because we’ll be trying it on the table
Beth: and then on the carpet as well
Oliver: on all different things
Nigel: if we have weights then they have to stay the same
The teacher briefly stops the class to give an administrative notice and then the group restarts:
Nigel: so what do you er predict will happen I think on the carpet is going to be more force than on smooth
Oliver: it will make more friction
Beth: yea carpet’s harder
Nigel: yea the rough surfaces
Oliver: will make more friction
Beth: carpet’s harder

Oliver: rough is harder harder on the carpet

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We can see here in the first sequence that Lucy has a different idea about what a fair test is and is struggling to conceive the plan in the same way as the others. This leads Oliver to provide a hypothetical example to try and help Lucy see how a test wouldn’t be fair if the weights weren’t the same. Lucy calls upon another peer to clarify the situation for her and this leads the group to work together to help Lucy see how there are other variables. The group members are drawing on their common understanding of how within a fair test some things need to stay the same, to help Lucy explore her thinking, but the sequence is interrupted by the teacher and after this the group move onto a new theme of predicting. The topic of fair testing does not come up again in this lesson and interestingly Lucy does not engage in the next sequence. The talk around making prediction is characterised by confirmations and reformulations as the children layer their ideas to come to a consensus about which surface material will require the most force to be exerted.

The pupils can be seen to move between talk types, depending upon the topic of discussion and what the range of existing ideas is. This extract demonstrates the importance of children encountering dissatisfaction with existing thinking within their talk if it is to ‘go somewhere’ for them. Although we don’t see Lucy move forward in
her thinking through anything that she says, the sequence may have provided a means for her to consider in new ways, re-evaluate her perspective and reflect upon it during the ensuing practical activity. When there is no challenge or exploration, as when the children were predicting, the talk does not appear to move children’s thinking forward. It functions as a decision making tool so that the group can confirm what they already know. This is of course an important function and in this case allows the group to move on efficiently to the measurement of friction and consideration of evidence. However, talk also has potential for facilitating new learning, where children explore ideas and move their thinking in new directions.
Appendix 9.6 Exploratory Talk

The kind of talk that shares and accumulates knowledge through the routine exchange of facts was strongly evident throughout the year (Appendix 9.1 and 9.5). It was rare that talk went beyond this to be the site of the active construction of scientific understanding. Often children worked in exploratory ways through the procedure of inquiry work and talk where children were grappling with the content of scientific concepts is more rarely heard; talk which was evidence of children sharing ideas, showing discomfort or dissatisfaction with their thinking, challenging each other and evaluating the fruitfulness of their own conceptions and conflict (Gunstone, 1994); talk which appeared to lead to new ways of thinking for the group.

In order to explore some examples of pupils using talk in exploratory ways to grapple with their ideas about scientific concepts, I will use two themes drawn from the teacher purposes for talk analysis (Table A9.3d). These themes are a) hypothesising and b) sharing ideas, evaluating them and coming to a consensus.

a) Hypothesising

It has been noted through studies of children’s ideas in science that learners tend to consider aspects of physical situations in limited ways, perhaps focussing on observable features (Driver, Guesne and Tiberghien, 1985). Requiring children to think in hypothetical ways, to try and talk about what may be happening, suggest mechanisms and processes and explore interactions in the natural world possibly has the potential to develop their thinking to a more sophisticated level and deepen their understanding. Some of the sequences of Exploratory Talk occurred when the teacher asked the pupils to hypothesise about what they think may be happening in a situation that they had experienced. An example of this follows, including three extracts of peer discussion which illustrate how this strategy led pupils to begin to think about a physical process and the interactions occurring, rather than just their observations.

During a lesson on dissolving, a pupil reminded Emma that the class had left a cup on the windowsill with water, salt and tealeaves in a few days earlier and they had not yet had the chance to review it. Emma took the opportunity to look at the remains in the cup and share observations with the children. She passed the cup around the room for
pupils to see and asked the groups to discuss ‘What is dissolving? What was going on in this cup?’ The groups began to discuss first about evaporation as water disappearing and turning into water vapour before they moved onto thinking about dissolving. Emma told them they can draw a diagram whilst they talk about it if they like:

**Extract 6: Dissolving**

*Yvonne:* it will dissolve but it evaporates doesn’t it and it goes into the water

*Ellie:* It’s like here the water then dissolves and then it goes in and it dissolves a little bit dissolves and so it’s like in the water wait here’s the salt and then the salt goes into the water

*Yvonne:* then it sort of

*Ellie:* it’s like

*Sam:* dissolves

*Ellie:* it dissolves yes it dissolves

*Yvonne:* dissolves

*Ellie:* and then it disappears

*Yvonne:* it doesn’t really disappear

*Ellie:* it evaporates in the water so it’s still there in the water

*Yvonne:* but you just can’t see it the salt goes into the water yea

*Sam:* all of this

*Yvonne:* water it’s still there in the water but you just can’t see it

*Ellie:* so it’s like

*Sam:* dissolves

*Ellie:* so it’s like here in the cup

*Sam:* dissolve

*Ellie:* and here’s the water the salt goes in there and then it disappears

*Yvonne:* so it’s not on the top

*Sam:* yea we’ve finished it

*Ellie:* so it sinks right to the bottom really

*Nathan* I’ll show you what dissolves means you always do I want to show what it means water water with if it has all the little bits in it and the water washes it and oh no it dissolves and oh it’s still there
Yvonne: you can see some of it at the bottom

After discussing again the idea of evaporation the group, Sam returns the group to dissolving:

Sam: the salt is here and then evaporates is where the water goes and turns into gas and then the water level goes down and leaves a mark that’s what evaporate is and dissolve is the things where the water breaks things up

Nathan: that’s what I said

Sam: tiny pieces that you can’t see

In this extract, although the children are clearly challenged in their thinking because of the dual processes of evaporation and dissolving that they have been asked to consider, it is possible to see that the group construct new ideas and make meaning about dissolving through their engagement with each other’s contributions. There are many features of cumulative talk as ideas layer but crucially also challenges which cause group members to reconsider their thinking. From the outset it can be seen that Ellie, Sam and Yvonne are comfortable with the idea of salt going into the water and they graft onto this the vocabulary of dissolving. Yvonne challenges Ellie’s idea about disappearing with a new way of thinking and in response Ellie seems to pick up on this. Although she uses the vocabulary of evaporation in this part of the dialogue, possibly by accident because earlier she had also aligned evaporation with disappearing, she ties in Yvonne’s idea with her own about salt being in the water, suggesting it is still there. Yvonne begins to reformulate and then clarifies ideas for Sam when he requests it. As Ellie and Sam take their new ideas into account, Nathan offers a new perspective with his hypothesis that there may be ‘little bits’. This language is taken up by Sam as he uses the idea to consider dissolving as breaking up into tiny pieces.

Later on in the lesson, another of the children in the class asks how they might see this process happening and the groups are asked to consider this:

**Extract 7: Atoms**

Nathan: not a microscope a magnifying glass yea that would be a lot better

Sam: it would be about
Nathan: what if it was really small and you can’t see it you’d have to use
Sam: what if it was an atom
Nathan: what’s that
Yvonne: it’s a small bit

This very short sequence is perhaps some evidence for the take up of new thinking about dissolving being a process of breaking down a solid into small pieces.

What the group appear to have done is work together to construct a new way of thinking about the process of dissolving. The group dialogue provides a site for the children to come to a new understanding about dissolving - that the salt is being broken into little bits, rather than just disappearing and this has moved them from recognition of the features of dissolving to considering the way in which the salt and water interact. They have begun to use new language to articulate their ideas and in doing so show that they are conceiving of the process in a different way and can ‘see the phenomenon with new eyes’ (Sutton, 2005, p.125). This was enabled by getting children to make explicit their ideas about the process, to represent what they think about the situation and by group members responding to critique of their ideas by peers. By doing this, they have been able to evaluate the idea of disappearing and decide to reconstruct as a group a model of dissolving.

In the following investigation planning session after a break in the collaborative activity, the joint thinking was briefly recalled by the group before they moved onto their discussion of procedure:

**Extract 8: Planning**

*Sam: what are we going to do*

*Ellie: shall we do what happens right well when mixed with water and then we can properly test*

*Yvonne: yea*

*Ellie: yea so shall we write what happens so we know*

*Nathan: how about talcum powder*

*Ellie: right we need to use just a little bit*
Nathan: disappear in hot water
Sam: dissolve
Nathan: yea that was it wasn’t it

The group seem keen to recreate their model of dissolving perhaps as a platform from which to think about their own investigation and although Nathan draws on the ‘old’ idea of disappearing. When prompted to rethink, he quickly concurs, suggesting he realises the new idea is more fruitful.

Emma reflected on this part of the lesson in the oral diary entry - ‘I hadn’t planned in the whole cup thing, I’d forgotten all about that…and getting that out sparked off a bit more conversation’ (EMMA ORAL DIARY 7). The intended learning was for pupils to investigate and know what dissolves in water and what doesn’t but the spontaneous discussion described above helped the children to create a shared understanding and conceive the physical process under investigation in more precise and clear ways. Children’s interview data after the lesson showed that there was an impact on learning and that they were aware that they had benefitted from each other’s ideas in developing their own:

Ellie: I learned more about dissolving and evaporating and what it means from people talking
Sam: You can learn things you didn’t know and you may know stuff people don’t know so you can share ideas and know new things
Nathan: I liked looking at the cup...we like put our ideas together

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b) Using the IDZ to analyse classroom talk - children sharing ideas, evaluating them and coming to a consensus

As it can be seen from the purpose for talk analysis described in Appendix 9.3, teachers drew heavily on activities where children were required to draw on their own conceptual structures, and share their thinking with each other. Very often this also involved children in making decisions, evaluating ideas and coming to a consensus.

This kind of activity aligns with constructivist approaches because in knowing pupils’ ideas, teaching can be planned accordingly but also because enabling pupils to draw on their mental construction of concepts is seen as a key process in learning (Driver,
Guesne and Tiberghien, 1985) because then they can relate this to any new ideas or experiences.

In order to illustrate how teachers facilitated peer group Exploratory Talk by setting tasks that required them to draw on their conceptual systems, evaluate ideas and come to a consensus, I will explore three extracts. In an attempt to make sense of why sometimes children take new understandings from a group dialogue opportunity and sometimes they don’t I will consider these extracts in terms of the concept of Intermental Development Zone (Mercer, 2000).

**Extract 9: Bones**
This extract comes from a lesson in Emma’s class which had a focus on developing understanding of the skeleton; it occurred at the start of a sequence of work on the human body. Emma collected the class together in the school hall in order to have enough space for the peer group activity which took up most of the lesson time. Emma began the lesson by inviting the children to draw on their experiences and contribute their ideas to a whole class discussion. She asked if anyone had ever broken any bones and a range of pupils supplied stories about wrists, arms and legs. After mentioning x-rays the group task was set. Pupils had to draw around a group member’s body on a large sheet of paper and draw inside what bones they knew, labelling them. The task was introduced as one which would help the teacher find out about what the pupils knew about skeletons, and the children were informed that they would be able to look at each other’s diagrams towards the end of the lesson in order to share ideas more widely. Group collaboration was emphasised, as was questioning, explaining and the importance of coming to a consensus. The groups engaged immediately in the task, although in the focus group, one child, Yvonne, who was rather timid and quiet stood back a little. Initially the talk was procedural with the group getting their large body outline set up but the group soon settled into the task, by collecting ideas about what to place in their body. The group began by focussing on the task of drawing bones but the discussion soon drifted:

*Sam: okay so let’s just do the skull we don’t have to go all fancy and do the eyelashes and the hair okay or the nails or paint them*
Ellie: I know let’s just do the skull

Yvonne: I’m not really good at skulls

And a few moments later:

Sam: shall we do the brain

And then other organs and bones are added:

Nathan: let’s do some something else right Sam can I do some now

Ellie: right let me do it

Sam: not yet Nathan Nathan you’ve got to draw the bladder

Nathan: yea I know

Sam: Nathan’s drawing the bladder I’ll draw kidneys too

Sam: no you are only drawing the bladder and skin

Yvonne: let’s go up to here

Nathan: how do you draw a bladder

Sam: look stop has it got a cross

Nathan: I don’t know how to draw it it’s like teeth

Yvonne: like drawing your teeth

Nathan: oh my gosh that’s my rib cage wow look at that

A little later a new idea is added:

Nathan: now what shall we do do you know something else

Sam: heart

Nathan: the heart is like over here

Ellie: yea

Nathan: no is not in the middle your heart’s not in the middle it’s over here wait it’s where I lay down

Yvonne: right er okay I have a thing that the heart’s

Sam: it’s there on me so it’s here

Ellie: so do the heart there

Yvonne: don’t actually do a love heart because it’s not a heart it’s not really a heart

Nathan: it’s my heart got to do a wiggly line

Ellie: no wait er we are meant to do the bones

Nathan: but we don’t know what they are called though

Ellie: yea I know well I think
Nathan: shall we do ankles
Ellie: wait I think this is called foot bone
Nathan: no ankle bone ankle bone ankle bone
Teacher: can I just ask the kidney is that part of the skeleton is it bones remember it’s just you need to draw the skeleton

In this sequence the group are working collaboratively, suggesting a range of ideas for what they can include in their diagram, checking additions with each other and commenting on the work in progress. The group appear to be a little indiscriminate with what they are adding, perhaps suggesting that they don’t have an adequate mental model of ‘skeleton’ or at least one which is consistent with scientific understanding, although this is perhaps prompted by Nathan’s two separate suggestions to add ‘something else’. Towards the end of this sequence, Ellie seems to realise that they need to be more careful about what they are adding to the diagram and she checks the group with a point about focussing on bones. She has obviously realised that they have blown off course but Nathan justifies the group’s action in the next line. However, this does seem to begin to steer the dialogue back on track and the teacher consolidates this move with her intervention so that a moment later the group are more focussed in their sharing of ideas:

Nathan: yea the ribcage is the skeleton
Sam: knee cap that’s a bone
Ellie: yea
Yvonne: yea knee caps like that
Nathan: that’s a bone Is your knee cap a bone is your knee cap a bone
Speaker (can’t identify): yeah it’s a bone
Teacher: what makes you think it’s a bone
Nathan: it cracks it cracked that’s a bone
Sam: cos you can feel it
Nathan: and it’s hard
Ellie: so yea it’s a bone
Nathan: it’s a bone
Yvonne: knee cap
Nathan: why are we doing kidneys anyway
Sam: it was your idea
Nathan: it wasn’t my idea to do the heart though
Yvonne: a heart’s not a bone

During this sequence a key moment is the single brief intervention by the teacher which moves the group from collecting their ideas for what they can add to their diagram to thinking more deeply about what they mean by the term ‘bone’. The group use the teacher’s prompt to begin to create boundaries to their group thinking – to identify possible definitions for the concept they are exploring. The teacher’s question leads the group to begin to create a shared understanding of what they mean by ‘bone’ – that it is hard; you can feel it and it can be cracked. The discussion moves on and the group seem to begin to use and apply this new common knowledge to their work and it helps them discard earlier inclusions to their model and begin to consider new ones:

Sam: oh so from the top
Nathan: that’s not called a nose bone is it it’s not called a nose bone
Yvonne: no
Sam: no it’s not a nose it’s not a bone
Nathan: yes it is
Sam: no it’s not a bone it isn’t a bone
Nathan: that’s a bone
Ellie: I think it’s a bone
Sam: it isn’t a bone
Nathan: look I can feel it’s a bone
Yvonne: yea ‘cos if you feel up here it’s kind of hard
Ellie: yea
Yvonne: what is it called then
Nathan: I don’t know let’s write
Sam: shall we write nose then
In this part of the dialogue even Sam, who was not sure if the nose was even a bone has been convinced by Nathan and Yvonne who use the group’s new common knowledge that ‘bone is hard’ to demonstrate their point. This new joint understanding of ‘bone’ seems to enable the group to not only categorise their ideas into ‘bone’ or ‘not bone’, as with the nose, but also helps them to move forward with their thinking when faced with the tricky example of the elbow. In the next sequence, Sam can be seen to be tentatively considering this and he begins to suggest ideas to the group about where bones meet. He is clearly not confident with this and does not strongly make his point but an interpretation could be that perhaps the focussed consideration of meaning which occurred earlier has enabled him to think more deeply through his contributions:

Sam: elbow shall we just write elbow or something what shall we write er where two
Pause
Sam: its funny bone that’s the funny bone
Ellie: yea that’s the
Nathan: elbow
Sam: it’s the funny bone
Nathan: Nno on your ankles it’s your funny bone that’s the funny bone
Yvonne: no it’s here
Sam: It’s where it’s where the two erm it’s where the two
And later
Ellie: yea put ankle bone and then question mark
Nathan: but it might it’s a bone there though isn’t it
Sam: but it might not be called an ankle bone
Yvonne: we’re not quite sure if it’s called a bone
Nathan: is it
Yvonne: it could be different
Sam: okay just write it
Nathan: I asked my mum I said I’ve broke my ankle bone it’s an ankle bone
Yvonne: yea but we don’t actually know that
Nathan: yea okay
This sequence seems to highlight that the children, faced with this new example, feel that their definition of ‘bone’ is now inadequate for their needs; they have identified something which needs further consideration. Sam begins to suggest that they need to think about the elbow and ankle in terms of two bones but he does not articulate any meaning further than this (the term joint is never used) and it is clear that the group are dissatisfied with their current ideas in the face of these examples; they know they have identified something different, something new to think about. They seem unable to interpret the idea of ankle and elbow in a satisfactory way based upon their current understanding of bone, knowing that these two new examples are different and they require further thinking. In this situation, the children show through their uncertainty that they see the need to construct a new coherent meaning and in this way the situation shows potential as a site for the development of understanding (Gunstone, 1994). At the end, Nathan draws on the group’s construction of ideas about bone to perhaps justify why he feels the ankle isn’t anything different but the group move swiftly from this topic.

Sam: wait teeth shall we draw teeth
Yvonne: no
Nathan: no that’s not a bone
Ellie: no that’s not a bone that’s not a bone
Nathan: not a bone or it wouldn’t come out
Ellie: yeah
Sam: teeth are bones
Nathan: they’re not
Sam: they are they’re the hardest bones
Ellie: I don’t think they are because if they come out then
Nathan: the hardest bone’s your skull
Ellie: I don’t think they are bones because like they can
Sam: come out
Ellie: yea and they wouldn’t come out easily so I think they are not bones
Nathan: and they wouldn’t be wobbly
Sam: they are bones
Nathan: yea write bones and a question mark
Ellie: write bones
Nathan: draw a line and write teeth just write teeth
Yvonne: write teeth
Ellie: yea just write teeth
Later
Sam: yea I know but they are bones they are
Nathan & Ellie: they’re not
Sam: I went to the dentist and he said they are bones
Ellie: what do you think Yvonne do you think teeth are bones
Yvonne: yea
Ellie: I don’t think
Nathan: yeah but that’s the dentist
Sam: they know about teeth
Yvonne: well you can see them in the xray
Nathan: you wouldn’t have an xray on your teeth
Ellie: why don’t we just leave it
Nathan: I know what that’s called that’s the bladder
Ellie: cos they fall out so why would they be like bone
Sam: yea they are the only bones that fall out
Nathan: that’s not a bone
Ellie: ‘cos that’s not a bone
Sam: the only bones that fall out
Ellie: the adult teeth
Sam: the adult teeth they only fall out if you bash them if you never bash them they won’t fall out
Ellie: okay right what else what other bones is there in the body
Later
Other child: you missed the teeth as well teeth are bone
Sam: yea everyone was arguing when I said teeth
In this sequence the ideas about teeth emerge on three different occasions. Sam suggests teeth as a possible addition to the diagram and when the group refuse to accept this, Sam draws on the shared understanding of ‘bone’ as being hard which was established previously, to help his case. A new idea about teeth falling out, which is not part of the group’s definition, is given as evidence for not including teeth, however the group seem to compromise by adding teeth to the drawing with a question mark (this could be because Sam is quite a dominant character in the class and this perhaps works in his favour in this instance). Sam later picks up the idea again, seemingly his dissatisfaction with the group’s model means he sustains his argument. He calls upon the fact that teeth can be seen on x-rays; an idea introduced into the shared consciousness by the teacher at the start of the lesson in relation to seeing bones. This seems to convince Yvonne but this is not enough to make the group change their diagram.

**Discussion of Extract 9 – teacher intervention to establish an IDZ**
During this sequence the teacher intervention was pivotal – it enabled the children to explicitly consider their own mental model of the concept of bone and create a joint understanding upon which to draw throughout the rest of the episode in order to assimilate or reject ideas. The ideas about ‘bone’ were called upon by different children in the consideration of the nose, teeth and joint and provided a set of guiding constructs with which to create a group consensus and model. In this way the brief teacher intervention which made them define their meaning of ‘bone’, provided structure to the children’s dialogue so that the children were not simply layering ideas through the task but co-creating a model of ‘skeleton’. Frustratingly, the notions of joint and the inclusion of teeth into the group’s joint model of the concept of skeleton went unresolved.

Interpreted through the notion of an Intermental Development Zone (IDZ), we can see how through this talk, the group created a state of shared consciousness focussed on the task and on the learning (Mercer and Littleton, 2007, p.21); a joint meaning through which the ideas could be filtered. The group created this IDZ after the intervention from the teacher; they co-constructed a shared understanding of what they meant by bone and used this throughout the rest of the dialogue in order to
select examples to add to their skeleton diagrammatic model. In this way, the teacher mediated the children’s learning by providing them with a way to structure their thinking in more systematic, abstract terms (Vygotsky, 1986) and to create an IDZ between themselves through which they could negotiate the co-construction of their model. The children operated from this point with a shared frame of reference which was maintained until the teeth problem emerged to challenge the IDZ. At this point the group were seemingly unable to adapt or extend the zone independently although there are moves towards this with the idea of writing a question mark. Ultimately, the children were unable to renegotiate the IDZ to take into account the new ideas and the situation was left unresolved.

From the oral diary entry Emma stated her ideas for the lesson, that the children would be sharing ideas and providing reasons:

The children were giving reasons why ‘I said to them beforehand you can’t just say no to somebody, you can’t just disagree with it, you have to back it up with some reasoning and I said that is what I’d like to see a bit more of today and so when they were saying they disagreed they had to back it up with something and I could see that coming through as I went round the children were giving reasons why.

Emma talked about her aims for groups to be working to bounce ideas off each other, to see things from other’s viewpoints and add together ideas. Before the lesson, she strongly emphasised the importance of working together and exchanging ideas but perhaps this framing of group discussion tasks simply as a place to share ideas and show what we know is unambitious (Resnick, 1999). As the dialogue shows, with the teacher’s prompt to create shared meaning as a frame of reference the children can take the activity further; understandings can be constructed dynamically within the talk. One of the children in the group showed some understanding of how this can happen through group dialogue when he shared his ideas about talking together for learning after the lesson:

Nathan: get ideas from other people
Sam: Because we share out ideas and understand and learn and we all agree on stuff like that and then we get better at science...you ask questions to see if they know and if they don’t you try and figure it out like that

The amount of time devoted to the group discussion in this lesson was worthy of a brief note. Although just allowing time for talk does not automatically mean productive dialogue will occur (Alexander, 2008c), in this case the extent of the group discussion allowed the group time to explore and return to concepts and weave ideas together. Time is not always made available to pupils and Emma refers to this tension during the final interview:

“It’s getting it to be really meaningful that’s er difficult... it’s important to spend that time and do them (group discussions), yes but I feel in a way there is less time...I think there is less time in the day and the timetabling to fit them in but they are valuable, yes.”

Extract 10 - Energy

During the topic of Environment, Simon designed a lesson which was intended to help children learn about how they can protect their school environment. Previously the children had created posters with general ideas around this theme so the theme of the lesson was not new to the class. In this lesson after a whole class discussion about why it is important to protect the environment, Simon briefly mentioned the idea of energy and where we get it from. He talked about power stations but quickly moved onto suggest it was time for the children to work independently. Simon set the groups off on an activity where they were required to place a series of cards holding suggestions for being environmentally friendly in order of ‘most to least effective’. The children immediately became engaged with the activity and set off in a purposeful way:

Tom: okay let’s go
Mark: right it says what would make the biggest difference to the school the biggest difference
Tom: right okay let’s think guys
Andrew: turning off
Tom: what could help the most with school
Ella: that’s quite good
Andrew: that’s like in the middle
Tom: that’s not gonna help so much tidy up after yourself
Andrew: walk or cycle to school
Tom: that would be good so we’ll put that
Mark: how would that be good
Tom: right okay
Andrew: how would that be good
Tom: right okay

Mark: how is that something good for school

From the transcript it can be seen that the group started well and begin to evaluate the ideas based on what they already knew about protecting the environment. We can see Ella doing this when she suggested that turning off lights is good and Andrew as he took her idea and placed the card in the middle. Tom also evaluated the statements, suggesting tidying up wasn’t helpful, preferring instead the idea of changing methods of arriving at school. The children collaborated and shared ideas but Mark’s interesting challenge, suggesting that the group think about what they may mean by something being ‘good’ can perhaps be seen as a request to think jointly. With this call Mark seemed to be suggesting that he needs the group to set up some frame of reference, some shared idea of what ‘good’ is on which they can draw as they evaluate the range of options for caring for the environment. Tom, who is a particularly dominant character within the group, seemed to ignore this but Mark persisted to no avail and the group moved on:

Tom: oh that’s quite a good one
Ella: switch off the projector when not being used yes it is a good one Tom
Tom: right we’ll put it near the top then
Ella: okay does everyone agree
Andrew: computer
Tom: does everyone agree
Mark: yes
Tom: okay line them all up not necessarily in order just randomly
Mark: Tom Tom this is good because if we don’t put pen lids on they’ll be wasted
 Ella: that’s not a good one
 Tom: yea ink will be wasted
 Mark: yea and then it won’t work anymore
 Tom: exactly it will be wasted
 Mark: why is the computer one there it’s always got energy
 Tom: right just randomly just randomly put them
 Mark: no

In this extract it can be seen that the children were working collaboratively, sharing their ideas, checking with each other for agreement before a decision was made. These are all features of Exploratory Talk.

One of the pupils, Mark once again injected a point of reference to the dialogue with his hypothetical idea about waste and then a short while later he called upon the idea of energy, which had been briefly referred to by the teacher, Simon earlier in the lesson. In doing this Mark was perhaps suggesting that these ideas may be suitable as reference points for the discussion but once again his apparent call for a shared understanding was ignored. However it was later adopted when the ‘computer being turned off’ was returned to:

 Ella: no that’s not important that computer
 Tom: but it uses electricity it uses lots
 Andrew: why should this computer always have energy
 Tom: because you are wasting the energy
 Mark: yea and you are wasting the energy when the pen lids go
 Tom: whatever

Here the group began to use Mark’s ideas to evaluate the cards and the children were challenging and questioning. Mark elaborated the earlier point about the pen lids being wasted; applying his reference point about energy and Tom even seemed to be moving towards this new way of thinking about the situations. Later in the dialogue, the group discussed things being expensive as a criterion for evaluation, as well as referring back to their first way of thinking, that things are ‘good’.
Discussion of Extract 10 – struggling to establish an IDZ
Throughout this episode, the children were almost completely on task, were physically engaged in the activity, showed good collaboration, some attempts at reasoned arguments and the ability to reach consensus. These are all desirable features of peer group talk but what seems to be happening is that the group have no frame of reference from which to work and through which they can develop their understanding. The form of the talk was strong but perhaps the content is less so which can be a challenge to overcome when setting up productive group discussion (Alexander, 2008c). The group try out a number of ways for finding meaning during their evaluation of strategies for improving the environment and they show persistence. They also demonstrate some dissatisfaction with their current ideas, exploring a range of new ones and in this way the discussion is ripe, and holds potential to allow the children to develop their thinking (Gunstone, 1994) until the activity ends with a whole class feedback. Interestingly, during this feedback one other group commented that letting felt pens go to waste was ‘bad because new ones need to be made which costs energy’. The teacher evaluated this positively, saying he hadn’t thought of it in those terms and the focus group quietly altered their ordering of cards in response, perhaps showing that they had now accepted this way thinking - of using the concept of energy for looking at the examples.

If this episode is looked at through the lens of the IDZ, it seems possible to interpret that it was this kind of structure that the group were missing. They had no joint bubble of shared understanding through which their ideas could be passed and so although they were engaged in exploratory forms of talk and showed resilience through the way they pursued a range of ideas, the content had potential to be more productive in terms of development of thinking had there been a shared communicative, conceptual space. In the oral diary entry after this lesson, Simon referred to the sorting activity:

...so the sorting activity I thought was perfect because you work in small groups, it facilitates discussions in terms of decision making, it’s talking about reasons... I think this is where the talk was really strong, the fact that I was able to engage all parties because it was small group work, it meant that they all could have a say... it provided opportunity for discussion.

Simon Oral Diary 5
By talking in this way about the group discussion, it is clear that Simon valued it as a forum for children to express their ideas and to have opportunities to share their reasoning. He also talked about the way the activity developed children’s understanding:

*I don’t think there was any deep understanding of environmental issues and learning but it was important that we touched on it...when I was planning for this I thought I’m just going to see they all understand that it’s important, that the environment’s important...but then part of the discussions were also part of what went well when they did the sorting exercise, there were some really good discussions and it was nice.*

**Simon Oral Diary 5**

The initial purpose of the activity for Simon was ‘so they had some ideas and they just had to decide which ones they wanted’ (Simon Oral Diary 5) so that they could move onto the next activity of planning what environmentally friendly strategies they may try and implement in school. These thoughts about the purpose of group discussion demonstrate that Simon was perhaps not thinking in terms of using dialogue to help develop an understanding of the impact of energy and as can be seen from the transcript, this meant that the pupils had no boundaries to their reasoning; no common guiding framework of meaning with which to shape their ideas.

The pupils talked about their learning after the lesson and one suggested that the group work ‘was more thinking what you do know’ (Ella) (Simon Pupil FG Interview 5). Tom commented that what had helped him was the energy statement made by another pupil in the whole class discussion ‘made me think a little bit’; before this he had ‘never thought that far’ (Simon Pupil FG Interview 5). This idea of thinking ‘going a distance’ is an interesting one; although the group worked collaboratively and shared interesting ideas, giving reasons and working critically with ideas at times, they were not able to use the talk to take them somewhere new, which is of course an important reason to utilise it; ‘if talk engages yet leads nowhere, its appeal will soon diminish’ (Alexander, 2008c, p.50).

**Extract 11 - Translucency**

Arun covered the topic of ‘Light’ during the study period and he worked through the concept of translucency with the class, engaging children in thinking about this property of materials and comparing it with transparency and opacity. In the first
lesson on this topic he began to cover the concepts of ‘opaque’ and ‘transparent’ by providing the groups with these words on cards and asking them to consider and discuss their meaning. He asked the groups to add their thoughts about these two concepts to a ‘light and shadow’ poster they were creating and then to share their ideas with other groups. This task was followed by both a whole class discussion to establish the point that shadows are formed by objects blocking light and a practical activity where groups were asked to create shadows with a range of opaque objects and continue to think about how they are formed. This whole class work and practical activity was also focussed on children noticing the position of shadows.

In the early part of the discussion activity the group had already agreed the fact that ‘if something gets in the way of a light’s ray it forms a shadow’ and this had been put on the poster. The group then considered the meaning of ‘transparent’ and ‘opaque’ and at times the teacher passed by the group encouraging them to elaborate on their ideas:

*Nigel:* does transparent mean it’s see through  
*Oliver:* that’s what I’m thinking  
*Lucy:* transparent means see through  
*Teacher:* yea if something is transparent what does it do  
*Lucy:* see through  
*Oliver:* the light can go straight through it  
*Lucy:* transparent means the light can go straight through it  
*Nigel:* goes straight through it  
*Oliver:* and obb... means it can’t get through it  

They return to the topic again a little later:

*Oliver:* put opaque  opaque means it er light can’t go through it  
*Teacher:* how would you describe that  
*Nigel:* if there was light it would hit it and it would form a shadow behind it.  
*Oliver:* and that’s called opaque  
*The teacher holds up a transparent ruler*  
*Beth:* it would go strai  
*Oliver:* go straight through it
Lucy: transparent transparent

It can be seen from this sequence that the group are layering their ideas about the relevant properties of materials and how they affect both the passage of light and shadow formation. Nigel begins by providing an idea for the group to test out, suggesting what he thinks to be true; both Oliver and Lucy quickly confirm this. The teacher’s intervention in the group encourages them to elaborate their thinking and Oliver’s subsequent suggestion about light travelling through transparent materials helps to make explicit the links between their observations and the physical process occurring. These ideas are then reused by the group in their consideration of ‘opaque’ and the teacher’s request for elaboration helps the group to connect their ideas with the process of how shadows are formed. After the lesson in his oral diary entry, Arun talked about how pleased he was with the way the children had talked:

They were engaged and they were putting lots of different ideas into it...the children seemed to be involved...we got some very good ideas... they were all on task and they contributed and they were actually really enthusiastic.

Arun Oral Diary 2

He talked about what his plans had been for what he wanted to achieve through the talk:

...was just to encourage them to talk within groups and be more cooperative...I was hoping that if children came up with misconceptions the others would challenge them and talk about it.

Arun Oral Diary 2

It seems that the group’s dialogue and the lesson as a whole had done much more than this. What this short sequence seems to have achieved was to make the children’s mental models explicit, enabling them to draw ideas together as a group and make connections between them. Thinking about this sequence in terms of an IDZ, this dialogue has perhaps helped to create a collective cognitive resource for the children, a common understanding about light and materials that they can draw on at a later stage. These ideas were then consolidated through the later whole class discussion when Arun drew out and established the points that transparent means that light goes straight through and opaque objects block light.

Although Arun was apparently considering his focus the form of the peer group talk, with contributions and questions being hoped for, it was in fact the content of the talk...
and the way in which it enabled the children to formulate a shared understanding, which was to have an impact on later group discussions. The oral diary evidence of Arun’s thinking, demonstrates that his priority was for something of a different nature to occur in the talk and so perhaps the potential for dialogue to construct a mutual contextual frame of reference within the peer group was not recognised.

In Arun’s next lesson on this topic, he gave the children a learning intention of ‘to investigate different materials and the shadows they form’. He began by giving the groups three cards with the words ‘transparent’, ‘opaque’ and ‘translucent’ on and they were asked to discuss what they thought the meanings were. This format follows a constructivist pattern of teaching; allowing the children an opportunity to share their ideas and make explicit their pattern of thinking about concepts. After having established that they were happy with definitions of transparent (‘you can see through it’) and opaque (‘you can’t see through it’, ‘it’s not like a window’) and with the help of a brief teacher intervention, that it means that a ‘shadow will be created’, the group moved onto considering ‘translucent’. Considered in terms of the collective thinking occurring, this initial review of common understanding by the group re-established the IDZ, which had been developed in the previous lesson; the group returned to the bubble of their joint knowledge in order to consider the new idea of translucency:

Oliver: I’ve no idea what translucent means
Beth: tran tran tras can’t say it
Lucy: translucent
Nigel: translucent
Beth: it means it means does it mean no shadow
Oliver: no that’s transparent
Beth: transparent
Lucy: all Nigel has to do is sit there and make sure we are working together (reference to the roles assigned)
Nigel: transparent
Oliver: that’s what transparent means translucent does anyone know what that means
Lucy: transparent means you can see through it
Oliver: yea that’s what Nigel said I don’t know what translucent is I don’t know if it’s like
Beth: what is transp
Oliver: I don’t know if it’s like when you can’t see through it
Nigel: when you can’t see through it
Oliver: but it does something that you can see through
Lucy: Beth said transparent
Beth: would transparent tramper transparent means means that light can go through it and it don’t make a shadow yea
Oliver: transparent means you can see through it
Lucy: see through it like see through leggings
Oliver: oh I think I’ve got a thing
Lucy: like tights
Oliver: translucent means you can go through it
Lucy: my nanna wears see through tights
Oliver: transparent means you can see through it
Beth: and it don’t make a shadow
Nigel: transparent means you can see through it
Oliver: but if it does make a shadow but it is just something on the outside but it’s see through yea
Nigel: what do you think this means though Beth seriously what do you think this means
Beth: it means er that it don’t make a shadow
Nigel: translucent yea it might not make a shadow
Beth: it might not make a shadow
Nigel: why don’t we all what do you think it means
Beth: it might make a shadow it might not make a shadow

This sequence begins with the group picking out where the gap in their understanding is for this task – that they do not have any conception of what translucency is; after Oliver rather strongly states his lack of knowledge to the group, they take turns
vocalising the new idea, perhaps trying it out, seeing where it could fit in their mental model. Beth is first to make a connection to their collective mutual understanding by referencing the idea of shadow formation. She draws upon this common knowledge to hypothesise in a questioning manner and in doing so provides the group with an idea to test. This is challenged by Oliver quite definitively and Beth seems happy to accept; Nigel signals his acceptance of this too with a repeat of the Oliver’s term. Oliver seems to move to re-establish consensual ideas about transparency, which is confirmed by Lucy. Oliver then extends a challenge to the group with a question and begins to hypothesise. At this point, Beth perhaps demonstrates her insecurity with the uncertainty of the situation and she begins reiterations of the joint understanding, which Lucy confirms for her and Oliver responds with a reformulation, giving the idea back in different more simplified terms. Lucy now begins to briefly move off on her own, elaborating her point with an example from prior experience which shows her understanding is firm on this concept. When Oliver offers a new idea and asks a hypothetical question, Nigel seems to consider this and repeats the idea, supporting Oliver and giving him space to elaborate. This turn shows that Oliver is beginning to draw on the joint understanding to combine ideas and he seems sure he has an idea worth following as he tells the group ‘oh I think I’ve got a thing’; in this way he seems to be offering a modification to the IDZ and he makes another suggestion. The combining of ideas Oliver has been attempting is briefly taken up by Beth before the confusion over the new term re-emerges. Beth moves between alternatives and Nigel seems to call on the group but the group begin to go off task, talking about the film Transformers.

Although the group seem to have identified a gap in their understanding, have strongly re-established their joint frame of reference with which to consider the passage of light through materials and have worked in a persistent way within their Intermental Development Zone, they have not been able to come to any consensual new understanding or adapt their model through the consideration of new ideas. They seem to have reached the limits of what they can do with their joint understanding and the IDZ breaks down. A few minutes after this sequence, the teacher approaches the group and Oliver addresses him, ‘I don’t know what translucent means’ and Beth
confirms ‘yea that’s what we are trying to do’; this short sequence restores focus to the group discussion. The teacher’s strategy from this point is to question the group and elicit what they think opaque and transparent mean and in doing so he enables the group to re-establish the IDZ:

Oliver: transparent means you can see through it but it don’t make a shadow translu no means it does make a shadow
Nigel: translu means
Beth: and you can see through it
Oliver: translu or whatever it says
Beth: transluscent

A little while later, the group begin to write some of their ideas down:

Oliver: how about we put this or maybe it means that er
Beth: or maybe
Nigel: it would be the opposite of transparent so you can’t see through it it’s like tinted it can be tinted
Oliver: what about like both of them it’s something that you can’t see through but it makes but it but it does not make a shadow
Lucy: what do you think Beth do you want to put your idea down as well
Oliver: translucent do you think it’s like well translucent if you think if you think it’s like it’s opaque and transparent
Beth: transparent to me it means you can see through it but it makes a shadow and that the other one means you can see through it but don’t make a shadow
Oliver: I thought it would be like both of them you know like
Lucy: but different

Discussion of Extract 11 – re-establishing and modifying the IDZ
In this sequence it can be seen that the group use the re-established IDZ to begin fresh considerations of the idea of translucence. Beth and Nigel work with Oliver this time to try to reason through combining the ideas about materials, shadow formation and the passage of light in order to modify the joint conceptual model and incorporate translucency. This leads Oliver to clarify for the group what they are trying to do,
allowing for some sort of generalised consensus to emerge - that the new idea of translucency is a combination of properties of the more familiar opacity and transparency, although it appears towards the end that perhaps Beth is less secure in her application of the vocabulary. The group have shown real persistence in their task of trying to hypothesise what this new concept may mean and although their learning has been mediated by the teacher through the setting up and re-establishing of the IDZ it has been a tricky task to come to some sort of wobbly consensus.

During this episode there is a good deal of talk which is exploratory in nature. Group members make invites for others to contribute, put questions, request clarification, and provide explanations, examples or elaborations that may help the group move forward and at times they hypothesise. There is coherence in the way they are working; they seem to be trying to work together and they do so generally with resilience, on the common goal of pinpointing the concept under discussion. They are drawing on features of their common understanding, working within their IDZ to follow a line of inquiry and construct new ways of thinking. The initial construction and re-establishment of the IDZ was enacted in a smooth fashion but with the realisation of a gap in understanding the group began to grapple with their thinking as they negotiated their way through the task set by the teacher. What this group transcript evidence shows is that the attempted modification of the IDZ to take account of new ideas provided the site for the productive exploratory talk to take place. After the group discussions are brought to a close, Arun asks them to share thinking with another group and ask questions:

*Other child: okay you can all ask a question*

*Nigel: okay what does translucent mean*

*Envoy: translucent means you can’t see erm you can’t see through it but it will let light in*

*Lucy: that’s just weird*  

Immediately the focus group place a question to the envoy about translucency and receive a new idea and when Oliver returns from his visit to a neighbouring group he brings yet another:
Oliver: I know what translucent means they told me it means it’s blurry but light can go through it you know like them windows
Nigel: it means only a bit of light can go through it
Oliver: yea light can go through but you can’t see through
Beth: a tinsie bit

Although the group don’t really have any time to consider these ideas together, perhaps at the close we can see the group beginning to modify their joint understanding as new thinking becomes available; through their consideration of the new ideas they have drawn on their collective resource of translucence being ‘a bit of both’ to arrive the notion of some light travelling through – a bit, ‘a tinsie bit’. At this point in the lesson, Arun uses a whole class activity around the interactive whiteboard to work on the concept of translucency, establishing that it means that some light can travel through and a faint shadow is created. The class are then given some materials to predict and test in order to apply their understanding of the new concept. It is clear that the group now draw on the newly modified joint understanding to engage in this task:

Oliver: that’s a faint shadow or
Nigel: no opaque dark shadow
Beth: so I bet erm so it’s what
Nigel: opaque
Oliver: you can see through it though
Beth: wait you’re stuck
Oliver: it’s what
Nigel: opaque
Oliver: that’s translucent it makes a faded shadow but you can see through it so it’s translucid
Lucy: translucent
Beth: plastic
Oliver: no translucid
Lucy: plastic wallet
Nigel: plastic wallet is translucent
Lucy: What’s the plastic wallet

Oliver: Translucent

It can be seen from the transcript that the children are talking in a cumulative ways as they draw on their joint understanding to engage in this task; the group use their common frame of reference to make and test predictions and consolidate their new collective thinking. After the lesson it is was clear that the children had developed their ideas about this alien concept:

Oliver: It means something it makes a little bit of light goes through and it makes a faint shadow

Nigel: It I think you can see a bit through it some light goes through it and the shadow is faint

Lucy: It means when I think it is see through and it casts a tiny shadow

Beth: It’s blury and then a shadow can come

There was also acknowledgment from the children that they hadn’t known what translucence was and that they enjoyed finding out:

Lucy: I liked learning about what translucent meant because I didn’t know what it meant

Nigel: yea

Oliver: yea I never knew in the first place and I got an idea from the other group of what it would be.

However, the group did not appear to recognise that talking together had helped them, suggesting that it was only through the teacher’s input that they had learned:

Beth: The bit where we learned about trans translu translucent it was really tricky and not many people knew what it was about and Mr X put what it meant on the board so if we forgot we would know

Oliver: He read out what it meant

Nigel: It was important it told us what it means so if we need to use it we can remember

The lack of metacognition from the children around how talk has just helped them to develop their thinking, demonstrates their limited recognition of peer group dialogue
as a relevant cognitive strategy and perhaps also their wider ideas about learning science with the teacher as controller of knowledge (Gunstone, 1994).

The oral diary entry from Arun after this lesson shows that he was pleased with the learning ‘they were certainly beginning to pick up what the idea of translucency meant’ (*Arun Oral Diary 3*), and that he had particular ideas about what he wanted to achieve through the group talk activity. Firstly he wanted the children to engage and have ‘plenty of opportunity for talking’ (*Arun Oral Diary 3*); indeed he picked this out as the specific way in which children were enabled to learn through talk in the lesson. He also wanted to have particular forms of talk occurring which would be beneficial to the way the groups could think together:

*I wanted them to question each other more, so I was explicit about saying to them actually, when the envoy comes to your group, make sure you question them. So just trying to get more questioning.*  
*Arun Oral Diary 3*

In addition to this he was very clear that he knew the children would struggle with the concept of translucency and had planned to structure the group discussions, whole class work and practical activity in order to support the development of thinking in this area:

...the idea of introducing it in the middle (teacher definition for translucency) was that they could first of all talk by their own ideas in a non-threatening way and tell them come up with your own ideas...that was then actually paving the way for the investigation...that was why I needed to put it in the middle...I didn’t want to introduce it at the beginning because I wanted them to just talk about it and find out their own ideas.  
*Arun Oral Diary 3*

What is interesting from this oral diary entry is it shows the careful teacher thinking about how to incorporate group discussion episodes into the whole structure of the lesson; the way in which group dialogue could be fed into teacher led sequences and then back to more pupil led. This structuring, alongside the prior learning from the earlier lesson, clearly had an impact upon the way in which pupils were able to construct their new idea about the passage of light through materials; it provided opportunities for the pupils to actively create a shared frame of thinking, incorporate new ideas, come to a consensus and test it.
Despite them not recognising it, the children did construct and consolidate new collective understanding through the group discussion, as can be seen from the range of transcripts. Their learning was mediated through talk by the way in which the teacher had planned for episodes of dialogue to intertwine with teacher input. Arun’s careful thinking about how to incorporate peer group talk throughout the lesson enabled the group to identify a gap in their knowledge and begin to work their way through ideas to modify their conceptual model. However, it can also be seen that Arun thought of the talk episodes in rather unambitious terms, seeing them simply as places to get children talking and help them find out ideas. What actually occurred within the talk was far more than that; through Arun’s facilitation of an IDZ, the group built a dynamic, collective intellect for the purpose of the activity (Mercer, 2000) and a shared construction of understanding emerged which helped the children move forward in their thinking about the concept they were working on.
## Appendix 10 – Defining pupil ownership of learning

### Appendix 10.1 - Focusing the concept: Pupil ownership of learning

<table>
<thead>
<tr>
<th>Reference</th>
<th>Literature overview</th>
<th>How pupil ownership of learning is conceived in this study</th>
</tr>
</thead>
<tbody>
<tr>
<td>Martin, A. and Hand, B. (2009) Factors Affecting the Implementation of Argument in the Elementary Science Classroom: A Longitudinal Case Study. <em>Research in Science Education</em> 39 (1) 17–38.</td>
<td>Case study which describes factors affecting one US elementary teacher’s attempts to develop classroom practice by embedding argumentation in science lessons. Results show that over time, the teacher shifted away from factual recall towards using more divergent questioning. This move from a traditional style of teaching led to the student voice being heard in the classroom, which in turn allowed for more argumentation by students. As the student voice increased, the teacher relinquished control to students. They became more active, framed their own questions and made decisions. Analysis of data was based upon teacher questioning, classroom dialogic interaction and elements of argumentation in student contributions.</td>
<td>Students frame their own questions and make their own decisions&lt;br&gt;Students communicate their ideas to each other&lt;br&gt;Students evaluate each other’s contributions&lt;br&gt;Students have space to use evidence and make claims based on their own inquiry&lt;br&gt;Teachers are facilitators of inquiry and promote dialogic interaction between students&lt;br&gt;Teachers use students’ prior knowledge&lt;br&gt;Direction of lessons and classroom discourse determined by students’ ideas/questions&lt;br&gt;Teacher is listener&lt;br&gt;Teacher encourages active participation in learning</td>
</tr>
</tbody>
</table>

Study which explored and analysed group work in physics. Case studies of students working and discussing in small groups on problems and projects. The research aimed to analyse the effect of ownership on the way the students carried out a task. The empirical work was carried out with 14 pre service teachers.

Theoretical perspectives of student ownership of learning were first used to develop two dimensions of ownership – individual student ownership and also group ownership. Within the groups, two particular students’ contributions were analysed in more detail to see how they were following their own ideas and determining the direction of the group - this demonstrates individual ownership of learning. Having two dimensions was seen to be beneficial because it increases awareness of impact of students’ influence on their own learning and also the opportunities and constraints. Concludes that more ownership leads to more effective learning.

| Creating spaces for everyone to contribute | Advocates students are resources for one another |
| Students are active agents of own learning | Students are enabled to relate prior experiences to new classroom activity |
| Students are free to start from their own experiences | Make decisions on process of task |
| Choice and control given to students | Students create their own questions and use them |
| Show autonomy and resilience with their questions | |

| Study which explored and analysed group work in physics. Case studies of students working and discussing in small groups on problems and projects. The research aimed to analyse the effect of ownership on the way the students carried out a task. The empirical work was carried out with 14 pre service teachers. Theoretical perspectives of student ownership of learning were first used to develop two dimensions of ownership – individual student ownership and also group ownership. Within the groups, two particular students’ contributions were analysed in more detail to see how they were following their own ideas and determining the direction of the group - this demonstrates individual ownership of learning. Having two dimensions was seen to be beneficial because it increases awareness of impact of students’ influence on their own learning and also the opportunities and constraints. Concludes that more ownership leads to more effective learning. |
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| Show autonomy and resilience with their questions | |

<table>
<thead>
<tr>
<th>Investigated ownership in teacher education through a self-study. Context was a master’s programme and 20 participants were in-service elementary teachers. The two authors worked on a teacher education programme, and their focus was to shift the focus towards the learners. The research questions were: What is ownership in this context, how can it be encouraged and what are teachers’ perceptions of it? Using a synthesis of the literature an initial framework was developed. In addition data was collected: Self-study - reflections on the programme classes Classroom observations and group discussions with teachers enabled an analysis of how ownership was being encouraged. A questionnaire and a survey were given to participants in order to gather teacher beliefs and perceptions of ownership in the context of their classrooms and their own masters’ level work. Using the corpus of data a framework was developed</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Build a community of learners</td>
</tr>
<tr>
<td>Articulate shared beliefs</td>
</tr>
<tr>
<td>Introduce faculty members’ beliefs</td>
</tr>
<tr>
<td>Explore and discuss prior knowledge and experiences</td>
</tr>
<tr>
<td>Identify expertise of the individuals for the group</td>
</tr>
<tr>
<td>Acknowledge and incorporate teachers’ issues and concerns</td>
</tr>
<tr>
<td>Identify contributions of all learners</td>
</tr>
<tr>
<td>Make decisions together about how to organize time</td>
</tr>
<tr>
<td>2. Explore content</td>
</tr>
<tr>
<td>Establish curriculum priorities, giving teachers a voice in developing those priorities</td>
</tr>
<tr>
<td>Include teachers' beliefs, interests and needs in planning course content</td>
</tr>
<tr>
<td>Expect and provide opportunities for teachers and faculty to participate in learning</td>
</tr>
<tr>
<td>Bring practical/relevant ideas together with theoretical discussions</td>
</tr>
<tr>
<td>Facilitate communication among teachers and faculty</td>
</tr>
</tbody>
</table>
which was intended to represent how to encourage ownership in teacher education. Conclusion was that ownership is multi-dimensional and cannot be given. It develops from structures which respect the voice, autonomy, power and responsibility of the learner.

Provide opportunities to share successes, ideas for change, reflect and self-assess
Use problems that teachers care about to structure reading, sharing and discussions
Link information from class to school or county goals
Encourage and provide time for teachers to present formally or share informally their expertise

3. Pursue in-depth learning
Share resources
Explore deeply in an area of professional interest
Discuss what in-depth learning encompasses
Create opportunities to hear all ideas
Structure time for collaboration and independent investigation
Represent learning in meaningful ways

Ownership cannot be given – it develops from a culture of respect, autonomy, power and responsibility.
| O’Neill, T. and Calabrese-Barton, A. (2005) Uncovering Student Ownership in Science Learning: The Making of a Student Created Mini-Documentary. | Interest in student ownership develops from inequity in science education and low levels of participation and interest in science. Informal learning settings were the context of the study and the research questions were: Why is ownership important among high poverty urban students? What are the qualities of student ownership in informal settings? Aim of study was to explore ownership of science learning in informal learning environments (after school science club). A critical ethnography was conducted over 3 years. Participants – 2 groups of 5 6th grade students. Mini documentaries were produced by students to show viewers their ideas about science in their lives. Students had the power and responsibility to select the content of their film. The documentaries became a data source along with observations, semi structured interviews with students and observations of science classes. Ownership was identified as an overarching theme. Student ownership of what they learn plays an important role in how they engage in the learning environment. |
| Ownership varies from student to student Ownership is a process and an outcome Ownership is both social and individual Students have positive perceptions of science in relation to self - talk about science as something important and useful to them as users and producers Students show investment in their work Use personal resources Students show pride in their work, science and self Students use their participation in the science event to effect positive change - agency Students are given choice and control Science is connected to students’ lives |
Appendix 10.2 - Working definition of pupil ownership

<table>
<thead>
<tr>
<th>Teachers:</th>
<th>Children:</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Encourage active participation</td>
<td>• Show autonomy e.g. frame their own questions</td>
</tr>
<tr>
<td>• Create spaces for everyone to contribute</td>
<td>• Demonstrate resilience in learning journey</td>
</tr>
<tr>
<td>• Advocate that children are resources for one another</td>
<td>• Show pride in work and positive attitude</td>
</tr>
<tr>
<td>• Provide opportunities for pupils to discuss their own ideas</td>
<td></td>
</tr>
<tr>
<td>• Identify pupils as active agents of their own learning</td>
<td></td>
</tr>
<tr>
<td>• Relate classroom activity to pupils’ prior experiences</td>
<td></td>
</tr>
<tr>
<td>• Encourage pupils to draw on previous knowledge</td>
<td></td>
</tr>
<tr>
<td>• Give choice, responsibility and control to pupils over focus and</td>
<td></td>
</tr>
<tr>
<td>direction of learning</td>
<td></td>
</tr>
<tr>
<td>• Use pupils’ contributions</td>
<td></td>
</tr>
<tr>
<td>• Encourage reflection on learning process</td>
<td></td>
</tr>
<tr>
<td>• Consult with pupils and draw on their ideas about the teaching and</td>
<td></td>
</tr>
<tr>
<td>learning process</td>
<td></td>
</tr>
</tbody>
</table>
Appendix 11 – Publications and presentations

Publications:


Conference Papers:

Hewitt, E., (2015) Using group discussion in primary classrooms: teachers developing thinking about science learning; ESERA Conference, Helsinki, Finland: August 31-September 4


Hewitt, E., (2013) Group discussion in primary science: teacher reflective oral diaries as a research tool; BERA Annual Conference, University of Sussex: September 3-5

Hewitt, E., (2012) How do teachers scaffold pupils to productive group talk in science?; BERA Annual Conference, University of Manchester: September 4-6

Poster Presentations:

Hewitt, E., (2013) A study of teachers engaging pupils in group talk in science; School of Education PGR Student Conference, University of Leicester; June 29

Hewitt, E., (2012) Engaging pupils in group talk which develops their scientific understanding; Second European conference of the Fibonacci project: Inquiry-Based Science and Mathematics Education: Bridging the gap between education research and practice, University of Leicester; April 26-27
## Appendix 12 Data collection methods - overview of timings

<table>
<thead>
<tr>
<th>Data Type</th>
<th>Emma</th>
<th>Arun</th>
<th>Simon</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Lesson observations</td>
<td>8 lessons observed</td>
<td>9 lessons observed</td>
<td>5 lessons observed</td>
<td>22 observed lessons</td>
</tr>
<tr>
<td>(Lessons ranged from 48-100 minutes long. See Chapter 5 Tables 5.1/5.3/5.5 for individual lesson timings)</td>
<td>Total: 525 minutes</td>
<td>Total: 680 minutes</td>
<td>Total: 322 minutes</td>
<td>25 hours 27 minutes</td>
</tr>
<tr>
<td>Peer group discussion</td>
<td>9 group recordings</td>
<td>9 group recordings</td>
<td>5 group recordings</td>
<td>23 group recordings</td>
</tr>
<tr>
<td>(See Appendix Tables A9.3a/b/c for precise timing for each group discussion)</td>
<td>Total: 246.25 minutes</td>
<td>Total: 287.5 minutes</td>
<td>Total: 121.5 minutes</td>
<td>10 hours 55.25 minutes</td>
</tr>
<tr>
<td>Teacher interviews</td>
<td>4 interviews</td>
<td>4 interviews</td>
<td>4 interviews</td>
<td>12 interviews</td>
</tr>
<tr>
<td>(approximately 35 minutes each)</td>
<td>Total: 138 minutes</td>
<td>Total: 132 minutes</td>
<td>Total: 126 minutes</td>
<td>6 hours 36 minutes</td>
</tr>
<tr>
<td>Children’s interviews</td>
<td>8 interviews</td>
<td>9 interviews</td>
<td>4 interviews</td>
<td>21 interviews</td>
</tr>
<tr>
<td>(approximately 9-10 minutes each)</td>
<td>Total: 73 minutes</td>
<td>Total: 79 minutes</td>
<td>Total: 46 minutes</td>
<td>3 hours 18 minutes</td>
</tr>
<tr>
<td>Oral diaries</td>
<td>8 entries</td>
<td>9 entries</td>
<td>5 entries</td>
<td>22 entries</td>
</tr>
<tr>
<td>(approximately 10-12 minutes each)</td>
<td>Total: 91 minutes</td>
<td>Total: 106 minutes</td>
<td>Total: 73 minutes</td>
<td>4 hours 30 minutes</td>
</tr>
</tbody>
</table>
10. References


Fernandez, M., Wegerif, R., Mercer, N. and Rojas-Drummond, S. (2001) 'Re-conceptualizing “Scaffolding” and the Zone of Proximal Development in the


Roulston, K. (2010b) 'Considering quality in qualitative interviewing', Qualitative Research, 10(2), pp. 199-228.


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