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<th>The role of linguistics in the learning, teaching and assessment of mathematics in primary education: a case study of a lower school in the United Kingdom</th>
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<td>Andrea Raiker</td>
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THE ROLE OF LINGUISTICS IN THE LEARNING, TEACHING AND ASSESSMENT OF MATHEMATICS IN PRIMARY EDUCATION: A CASE STUDY OF A LOWER SCHOOL IN THE UNITED KINGDOM

by

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A thesis submitted for the degree of Doctor of Philosophy

Of the University of Bedfordshire

February 2008
This doctoral research was concerned with the role of language and its implications for the learning, teaching and assessment of mathematics for children aged 4-9 years. Earlier research by the author had established language and assessment as bridges enabling learning although they had the potential to increase the divide between teacher and learner. Reflection raised the question on how children achieved in mathematics despite potential difficulties with language and assessment.

Review of the literature concluded that resources and socio-cultural norms were also bridges between learner and teacher. A model was established of the relationships and processes between all perceived variables that provided an external, theoretical structure to be evaluated against structuralist, pragmatic and integrational linguistic approaches and empirical outcomes.

The overarching approaches adopted were institutional ethnography and case study. An appropriate methodology was devised whereby sophisticated ICT equipment captured all visual and speech events during classroom interactions. Frequency analysis at word level, content analysis at utterance level and discourse analysis at total speech level triangulated with content analysis of interviews and evaluation of documentation completed the empirical research.

Data analysis revealed five registers of children’s talk. Evidence suggested that the peer-peer ‘conditioned talk’ used in focused group work was the most effective for learning as it enabled them to discern the small steps in the inferential leaps in discourse made by their teachers, work out problems together, inform their peers, share findings and reinforce each others’ learning. Learners’ language showed aspects of structural, pragmatic and integrational linguistics, confirming a conclusion of the literature review that the various linguistic approaches discussed should be used to support and not exclude each other.

The contribution made to knowledge is the ethnomethodology provided by the model, ICT resource and the five registers of talk revealed by the linguistic approach to discourse analysis. Teachers would be able to understand nuances of language used by their pupils and acquire essential skills and tools to put into effect the personalised learning agenda. Peer-peer observation of teachers would be an appropriate platform for the observation of the different registers used by learners, the resources that generate those registers, and their most effective use to close the gap between natural language and the subject specific language of mathematics.
In memory of Audrey and John Kenneth Wilson
List of contents

Abstract
List of contents ................................................................. I
List of tables ................................................................ VI
List of figures ................................................................ VI
List of discourse extracts .................................................. VI
Acknowledgements ............................................................. IX

Chapter 1: Introduction ............................................................. 1
  1.1 Background to the study ............................................... 1
  1.2 The research questions ................................................ 5
  1.3 External factors influencing the study .......................... 6
  1.4 The course of the study ............................................... 9

Chapter 2: Literature Review ..................................................... 16
  2.1 Introduction .................................................................. 16
  2.2 Statement of Self .......................................................... 17
  2.3 Language and lower school mathematics ...................... 19
    2.3.1 Introduction ........................................................... 19
    2.3.2 Howard Gardner, language and mathematics ............ 20
    2.3.3 Natures and functions of language and mathematics ... 23
    2.3.4 Structuralist and semantic linguistics ...................... 28
    2.3.5 Pragmatics ............................................................ 37
    2.3.6 Integrational linguistics .......................................... 47
    2.3.7 Language and power ................................................. 52
      2.3.7.1 The teacher’s power ........................................... 53
      2.3.7.2 The transfer of power through group work ............ 56
      2.3.7.3 Teacher/learner collusion ................................... 59
  2.4 Language, lower school mathematics and threshold concept theory .... 60
    2.4.1 Introduction ........................................................... 60
    2.4.2 The changing context of school mathematics .......... 61
    2.4.3 Mathematics: a mental construct or external reality? ... 70
2.4.4 Threshold concept theory and language.................................74
2.4.5 Liminal space.................................................................77
2.4.6 The mathematics teacher’s role...........................................84

2.5 Language, lower school mathematics and resources.....................90
2.5.1 Introduction.........................................................................90
2.5.2 Brain function, language and resources................................92
2.5.3 Resources in the classroom................................................98
2.5.4 Resources and learning styles.............................................101

2.6 Language, lower school mathematics and assessment..................104
2.6.1 Introduction.........................................................................104
2.6.2 Current policy.................................................................108
2.6.3 Assessment for Learning....................................................112

2.7 The Learner/Teacher Dynamic................................................121

Chapter 3: Methodology....................................................................124

3.1 Introduction.............................................................................124
3.2 Statement of self......................................................................125
3.3 Choice of research sample......................................................127
3.4 Choice of paradigm and methodologies....................................129
  3.4.1 Institutional ethnography..................................................129
  3.4.2 Choice of case study........................................................134
  3.4.3 Methodologies...............................................................136
  3.4.4 The choice of both qualitative and quantitative methodologies..138
3.5 Developing an appropriate method of data collection..................141
  3.5.1 Pre-MA TTA funded research...........................................141
  3.5.2 Master’s research............................................................142
3.6 Current research.......................................................................146
  3.6.1 Validity.............................................................................146
  3.6.2 Reliability.........................................................................148
  3.6.3 Ethics...............................................................................150
  3.6.4 Maintaining the natural flow of the lessons........................152
  3.6.5 Interviews........................................................................153
  3.6.6 Pilots...............................................................................155
  3.6.7 Documentation...............................................................156
Chapter 4: Data Analysis

4.1 Interviews

4.1.1 Interviews of adults

4.1.1.1 Introduction

4.1.1.2 Rationale for content analysis

4.1.1.3 Themes

4.1.1.4 Subcategories

4.1.1.5 Units of meaning

4.1.2 Interviews with children

4.2 Word analysis

4.2.1 Introduction

4.2.2 Development of Shuard and Rothery’s categorisation of words

4.2.2.1 Rationale for choice

4.2.2.2 Compatibility with an ethnographic approach

4.2.2.3 Validity of findings of Master’s research

4.2.2.4 Current research: range of word analysis

4.2.2.5 Deictic expressions

4.2.2.6 Development of Shuard and Rothery analysis

4.3 Utterance analysis

4.3.1 Introduction

4.3.2 Rational for utterance analysis

4.3.3 Categorisation of individuals

4.3.4 Categorisation of intentions

4.3.5 Exemplification of categories

4.3.6 Analysis of teacher generated talk during whole class input and of children’s response

4.3.6.1 Teacher generated talk

4.3.6.2 Children’s responses

4.3.7 Analysis of teacher/teaching assistant generated talk

4.3.7.1 Analysis of the discourse used by children during practitioner-led activities

4.3.7.2 Analysis of peer-peer talk

4.3.7.3 Analysis of group work
Chapter 4: Total speech analysis

4.4 Total speech analysis

4.4.1 Introduction

4.4.2 A core of literal meanings

4.4.3 Missing out information

4.4.4 Teacher talk and children’s abilities to construct understanding

4.4.5 Two new registers

4.4.6 Group work

4.4.7 Analysis of practitioner-led talk during group work

4.4.8 Children’s talk in unsupervised group work

4.5 Summary

Chapter 5: Learner/Teacher Dynamic: secondary analysis

5.1 Introduction

5.2 Findings from word and utterance analysis and the Learner/Teacher Dynamic

5.3 Resources and a pragmatic approach to the Learner/Teacher Dynamic

5.4 Total speech analysis and the Learner/Teacher Dynamic

5.5 Threshold concept theory and the Learner/Teacher Dynamic

5.6 Speech registers and the Learner/Teacher Dynamic

5.6.1 Conditioned talk

5.6.2 Transitional and social talk

Chapter 6: Conclusions, Implications and reflective review

6.1 Conclusions

6.1.1 The role of peer-peer language in the learning, teaching and assessment of mathematics for children in the four to nine age range

6.1.2 The role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the four to nine age range

6.1.3 The implications of the insights given by linguistics into the learning, teaching and assessment of mathematics for children in the four to nine age range
6.2 Implications of the findings for current policy and practice ................................. 284
6.3 Reflective review of the research ........................................................................ 287

Tables

Table 1: Relationship between resources and language, brain function and
Briner’s modes ........................................................................................................... 97
Table 2: Presentation types identified in PIPS mathematics assessment .................... 113
Table 3: Record of meetings with the research school .............................................. 150
Table 4: The interview questions to adult participants ............................................. 161
Table 5: Subcategories attracting ten or more responses ....................................... 168
Table 6: Venn diagram drawn by March/Class 3/Teacher for Group 2 ..................... 227
Table 7: Relationship between Bruner’s modes, resources and language ................. 260

Figures

Figure 1: The teaching-learning interface ................................................................. 44
Figure 2: The relationship between formative and summative assessment .............. 107
Figure 3: The Learner/Teacher Dynamic ................................................................. 122
Figure 4: Themes and responses ............................................................................. 162
Figure 5: Nov/Class 1 seating plan ......................................................................... 220
Figure 6: Nov/Class 1 seating plan with box ........................................................... 222
Figure 7: The Learner/Teacher Dynamic ................................................................ 254
Figure 8: The Learner/Teacher Dynamic configured to reflect the structuralist approach to linguistics ................................................................. 257
Figure 9: The Learner/Teacher Dynamic configured to reflect the pragmatic approach to linguistics ................................................................. 262
Figure 10: The Learner/Teacher Dynamic configured to reflect the modified integrational speech approach to linguistics, teacher-centred mode ....... 266
Figure 11: The Learner/Teacher Dynamic configured to reflect the modified integrational approach to linguistics, learner-centred mode .......................... 271

Discourse extracts

Discourse extract 1: Examples of closed questions inviting low cognitive answers ....... 192
Discourse extract 2: Example of follow-up tokens relating to mathematics .............. 193
Discourse extract 23: Conditioned talk.................................................................232
Discourse extract 24: Transitional talk...............................................................233
Discourse extract 25: Social talk...........................................................................235
Discourse extract 26: A child’s lack of language to explain.....................................236
Discourse extract 27: Effective use of repetition with SEN children.............................241
Discourse extract 28: Group play in Reception.........................................................243
Discourse extract 29: Use of unfocused language by Reception teacher....................244
Discourse extract 30: Instruction in Reception (i)......................................................245
Discourse extract 31: Instruction in Reception (ii).....................................................245
Discourse extract 32: Transitional talk as a bonding strategy....................................248
Discourse extract 33: Clarity given by total speech analysis.......................................249

Appendices

in The Cambridge of Journal of Education 32: 45-60..............................i
Appendix B: Bar chart of scores in reading, writing and mathematics
from pre-2004 Ofsted reports of Bedfordshire lower schools.............xix
Appendix C: Analysis of PIPS data........................................................................xx
Appendix D: Sample of field notes........................................................................xxiv
Appendix E: School Self Evaluation Form 2006 marked up.................................xxvii
Appendix F: Examples of letters of informed consent (signatures hidden)..............xlv
Appendix G: Ethics approvals................................................................................xlix
Appendix H: Interview schedules...........................................................................lx
Appendix I: Brenner et al.’s approach to content analysis....................................lxiv
Appendix J: Coding of interview utterances for content analysis.........................lxvi
Appendix K: Interview utterances; themes, subcategories and units of meaning...lxvii
Appendix L: Transcripts of pupils’ group interviews...............................................xcii
Appendix M: Sample transcript taken from video data............................................xcviii
Appendix N: Sample of mathematical words used during teacher generated
input/activity..........................................................................................................cxvii
Appendix O: Sample of mathematical words used during teacher generated
and group activities.............................................................................................cxix
Appendix P: Developed Shuard and Rothery analyses...........................................cxxiii
Appendix Q: School Improvement Partner Autumn Visit Reports (2007)
marked up...........................................................................................................cxxxii
Acknowledgements

I would like to thank my two supervisors, Doctor Clare Walsh and Doctor Neil Burton, for their invaluable advice and support in the production of this thesis. Also, I would like to acknowledge the work of Rob Crossland in creating the technology on which my methodology depended. I would like to recognize the patience of Doctor Sandie Sargent, Doctor Thomas Smith and Julia Croft in proof reading and commenting on the manuscript and commenting on the work, and for piloting the methodologies. Finally, I would like to express my appreciation of Mr. Ahmed Eldin, consultant surgeon, whose care and expertise enabled me to complete and present this thesis.
1 Introduction

1.1 Background to the Study

This study is concerned with the role of language and its implications for the learning, teaching and assessment of mathematics in the early years and the first four years of primary school education (for children aged 4-9 years). The initial stimulus for the study arose from the findings of an action research project (Raiker and Price, 2000) funded and published by the then Teacher Training Agency (TTA) as part of that organisation’s drive to raise awareness of evidence-based practice amongst teachers. The findings of this research on the role of confidence in the effective teaching of data handling to Year 4 children taught at the researchers’ respective schools reflected those of other research of the time (for example Buxton, 1981; Sewell, 1981; Cockcroft, 1982; Briggs and Crook, 1991; Briggs, 1993) that many lower school teachers found difficulty with mathematics and that these difficulties were transmitted to the pupils they taught.

Raiker and Price (2000) explored the reasons why these feelings of confusion arose in the first place. Lower school teachers teach essential but basic and uncomplicated mathematics involving concepts they would have encountered when they were young children. The findings from the research suggested that the lower school teachers in the study who had problems in teaching the early stages of mathematics acquired these difficulties during their own lower school years. Their confusion was manifested as lack of confidence in teaching mathematics and insecure subject knowledge and understanding. This was apparent in their teaching. Of particular interest for this study was the finding that not all children absorbed the confused thinking and incomplete or faulty
explanations of their teachers. Some children clearly understood the concepts being taught and were able to demonstrate this through both their spoken language and their recorded work. This suggested that some children could bypass their teacher’s lack of understanding as it manifested itself in the latter’s language.

Subsequently, the role of spoken language in the learning and teaching of mathematics became the focus of my Master’s research (Raiker, 2000; Raiker, 2002). Data was collected from six Bedfordshire lower schools from classrooms where mathematics was taught according to the legal requirements of The National Curriculum (DfEE, 1999a), the teaching methods recommended by The National Numeracy Strategy (DfEE, 1999b) and to some extent the language listed in the accompanying document Mathematical Vocabulary (DfEE, 1999c). As the findings from this research provided the stimulus for both the research questions to be addressed by the current study, and the model of a dynamic between learner and teacher in the learning, teaching and assessment of mathematics in the early phases of education proposed in Chapter 2, a brief discussion of those findings is necessary.

Analysis of data collected for my Master’s research (Raiker, 2000) confirmed that the teaching of mathematics in early years and lower school settings involved the use of real life, concrete, visual and human resources, each of which relies on spoken language to establish understanding (O’Sullivan et al., 2005). However it was evident from the phenomenological analyses (Hycner, 1985) of the spoken language used by teachers and learners that there was a divide between the children's individualised, tentative, and personal contributions to class-teacher interactions and those of the teachers which were highly structured, of high status and authoritarian. This contrasted with the open, free-flowing and dynamic sample group discourse. Analysis showed that aspects of the social semiotic that
is language separated teacher and children rather than uniting them. However the evidence also demonstrated that ‘experts’ in the Piagetian (1972) sense could sift the correct precise mathematical meaning from everyday language and apply it consistently in a mathematical context whereas ‘novices’ had difficulty. This supported the conclusion that teachers and pupils appeared to attribute different meanings, nuance of meaning or importance of meaning to mathematical words.

The evidence demonstrated that the teachers involved in the study used language imprecisely and incorrectly. This caused confusion and opportunities for misconceptions to arise in some of their pupils’ thinking. Moreover, the analysis showed that teachers used a greater range of words than their learners in teacher-class interactions, and that learners used a greater range of words in teacher-class interactions than when engaged in discourse during their group activities. This indicated that teachers created opportunities to generate the use of precise mathematical vocabulary and meaning but evidence from the sentence analysis of low levels of explanation and open questions/answers suggested that more use could be made of these opportunities. The greater range of spoken language used by teachers itself may have caused confusion because of the multiplicity of imprecise meanings implied in the words and some children’s inability through inexperience to extract the correct meanings for the mathematical context. Low rates of repetition by both teachers and learners and lack of experiences whereby children could talk and explore meanings appeared to create confusion and present opportunities for the growth of misconceptions. The Master’s research also indicated that the use of correct mathematical terminology as defined in Mathematical Vocabulary (DfEE, 1999c) did not necessarily demonstrate conceptual understanding.

There was evidence that teachers questioned children to encourage them to externalise their knowledge and their mental models. Teachers assessed
understanding informally through teacher-class discourse and contact with individuals during the activity sessions. The evidence indicated that not all children contributed to the formative assessment interactions. If errors were revealed by the answers of those children who did contribute, leading questions were asked to elicit correct answers. Very few examples were recorded of teachers asking open questions to bring out misconceptions so that they might be addressed. In fact opportunities for teaching particular points to minimise the formation of misconceptions were ignored. Indications that teachers taught to the social imperatives of the nationally prescribed mathematics curriculum and not in response to individual children’s levels of understanding and styles of learning were strong.

A different picture emerged from the analysis of sample group discourse in the class lessons observed. Spoken language brought the children together. Analysis indicated the importance of spoken language in the growth of shared understanding. Evidence of Piaget’s (1972) novice/expert continuum, Vygotsky’s (1986) regulative communications and collective monologues and Wittgenstein’s (1973 trans.) ‘inner processes in need of outward criteria’ was revealed. Different children assumed the role of teacher at different times and in different ways, creating a rich social environment where individuals could construct meanings according to their learning style.

Reflection on these findings suggested that a linguistic approach to this thesis might provide deeper insights into not only how language supported or hindered the learning, teaching and assessment of mathematics in lower schools but also how children achieved in mathematics, despite difficulties with language and speech interactions. Difficulty with language is one of the triad of indicators for the identification of autism, the others being problems with social interaction and a tendency towards literal mindedness. Despite difficulties with language and
social interaction, two fundamentals in the learning of mathematics confirmed by the Master's research, autistic children appear to learn mathematics, some showing particular ability in the subject (Noens and Van Berckelaer-Onner, 2004). This suggested that there were other factors as well as language enabling children to learn mathematics, confirming the earlier research on confidence in the effective teaching of data handling (Raiker and Price, 2000) whereby children could bypass discrepancies in their teacher's delivery as manifested in the latter's language.

1.2 The research questions

The pedagogy adopted for this research comprises approaches to learning that are based on individual, rather than social, needs. These approaches include the foregrounding of the role of language in the learning, teaching and assessment of mathematics beyond this. Visual and kinaesthetic learning are both engaged in autistic classrooms. There is an emphasis on the interpersonal skills of the teacher to overcome the barriers inherent in autism to facilitate the outcomes of reflection and introspection by the learner. As well as deeper research into the study of spoken and written language, data on resources used in lessons and the relationship between teacher and learner in connection with language use would also be collected and analysed. The focus would be on determining the role of language relative to those of resources, learner/teacher relationships and the socio-cultural context of the mathematics curriculum and its delivery. In order to do this, the various elements identified would be represented as a model to enable reflection and evaluation on the role of language. The research questions to be addressed in this study were therefore confirmed as being:

1. That is the role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?
2. What is the role of peer-peer language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?
3. What are the implications of the insights afforded by linguistics into the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

1.3 External factors influencing the study

As well as satisfying the intellectual curiosity of the author in pursuing the answers to these questions on the teaching, learning and assessment of mathematics, there is relevance from a national perspective. The mathematics element of The National Curriculum (DfEE, 1999a) is still being reviewed and reissued, the latest document being The Primary Framework for Literacy and Mathematics (to be referred to henceforth as The Primary Framework) published in September 2006. In other words, the Government has acknowledged that, despite twenty years of curriculum initiatives to increase attainment beginning with the introduction of a national curriculum in 1988, the teaching and learning of mathematics is still not resulting in sufficient numbers of children achieving the required standard. The Primary Framework (2006a:2) states that: ‘Nearly a quarter of 11-year olds are still not confidently attaining Level 4 or above in mathematics by the time they leave primary school’. Level 4 is the level of knowledge, understanding and skills in mathematics deemed to be appropriate for the ‘average’ eleven year-old to have achieved. This level is defined by the attainment levels that conclude The National Curriculum document and form the syllabus against which children are tested at eleven.

The Primary Framework (2006a) also addresses shortfalls in children's attainment in literacy, the ability to use language to speak, listen, read and write (Rose, 2006). According to this document the foci for development in literacy are directed at raising standards in writing and in early reading, including phonics. Speaking and listening together remains a strand within the literacy element of The Primary Framework. In the early years, particular emphasis is placed on communicative skills. Thus Rose (ibid.:7) states that: ‘greater attention should be
paid to the development of children’s speaking and listening skills’ and that: ‘phonic work should be set within a broad and rich language curriculum that takes full account of developing the four independent strands of language- speaking, listening, reading and writing- and enlarging children’s stock of words.’ (ibid.:7).

The audience for this document is: ‘everyone involved in teaching children aged from 3 to 11’ (ibid.:1). There is no directive or rationale given to these practitioners as to why speaking and listening beyond the early years should be specifically developed. This is in spite of the Office for Standards in Education’s (Ofsted) findings that speaking and listening were: ‘the weakest aspects of English’ and that the argument for not planning specifically for these aspects was the misguided assumption that: ‘talk happens naturally in lessons anyway’ (2006:75).

This lack of emphasis on speaking and listening is borne out by previous research into the relationship between spoken language and mathematics (Raiker, 2002). The findings suggest that problems in the teaching and learning of mathematical concepts by young children might in part arise from and be compounded by misunderstandings in the meaning of the spoken language involved. The evidence demonstrated that the teachers involved in the study used language imprecisely and incorrectly. This caused confusion and the appearance of misconceptions in their pupils’ thinking. The Primary Framework (DfES, 2006a) is a document that combines information grounded in research and statements of core learning in literacy and mathematics. However, there are no linking statements to suggest that imprecise and incorrect use of language could be detrimental to mathematical understanding. The document Mathematical Vocabulary (DfEE, 1999c), which was published at the same time as The National Numeracy Strategy (DfEE, 1999b), is neither mentioned nor are its contents incorporated in The Primary Framework (DfES, 2006a). The former emphasis on the importance of the use of subject specific vocabulary in the
teaching of mathematics appears to have disappeared from current advice on what constitutes good mathematics teaching.

It can be argued that the relevance of this study goes beyond the lower school years. It has been stated that nearly a quarter of lower school children leave the lower school phase without having attained the required standard in mathematics. With this deficit they enter a secondary school system of which, according to Smith (2004:v): ‘so many important stakeholders believe there to be a crisis in the teaching and learning of mathematics in England’. Smith (ibid.:21) expresses concern that the Chief Inspector’s view was: ‘that shortages in specialist teachers in mathematics are having an adverse effect on pupils’ performance’ and provides evidence that the position in England is ‘strikingly worse’ than in other Organisation for Economic Co-operation and Development (OECD) countries. Subsequently, he notes the then TTA’s concern over the lack of students entering Postgraduate Certificate of Education (PGCE) courses in mathematics. Smith continues to report that there was a shortfall in the region of 3,400 teachers of mathematics in England, and that over thirty per cent of those currently teaching mathematics did not have a post-A level qualification in the subject (ibid.:22). Smith argued that, as well as the lack of suitably qualified teachers, there was an inappropriate secondary curriculum and qualifications framework, inadequate continuing professional development (CPD) and resourcing. However, as almost twenty-five per cent of pupils leave the lower school phase not having reached the required level of attainment, it would appear that some of the issues identified by Smith have their roots in pre-secondary education. My prior research suggested that issues with the language used in mathematics education might be a contributory factor. Further understanding of the role of language in the learning, teaching and assessment of mathematics would not only help early years and lower school practitioners enhance children’s
achievement, but there could be a subsequent impact on these children’s attainment in the secondary phase and beyond.

1.4 The course of the study

The purpose of this research was to identify the implications of a structured study of language for the learning, teaching and assessment of mathematics in the lower school phase. It is grounded in a consideration of the findings from my Master’s (Raiker, 2000) and TTA funded research (Raiker and Price, 2000). These studies demonstrated that the language used in learning, teaching and assessment could separate teachers and children, as well as forming a bridge between them. This affected the quality of learning and understanding that took place in mathematics lessons. Another influence on the current study came from a consideration of the ability of autistic children to learn mathematics despite difficulties with language and social relationships. Consequently the role of resources, learner/teacher relationships and the socio-cultural context of the curriculum and its delivery, missing from both my Master’s (Raiker, 2000) and TTA funded research (Raiker and Price, 2000), were acknowledged to be of crucial importance to this study. Growing awareness of the relationships between learner, teacher, language, assessment and resources within the socio-cultural context of the curriculum and its delivery suggested that they could be presented as a model of learning, teaching and assessment in mathematics. Its form would be determined by reflection upon and critical evaluation of the literature.

The literature review will begin in Chapter 2 with a statement of self as this research is ethnographic (Hammersley and Atkinson, 1994; Gee and Green, 1998; Denscombe, 2003; Cohen et al., 2005). Approaches to linguistics pertinent to the learning, teaching and assessment of mathematics and to the establishment of a model of learning, teaching and assessment of lower school mathematics are important areas for consideration in this review. The prevailing
taxonomy of utterance construal being focused on literal meaning in such fields as structuralist and semantic linguistics will be examined. The underlying assumptions on which literal meaning is based, that words and sentences have fixed meanings that are free of context, are questioned. The discussion will evaluate an approach to language used in mathematics lessons that is based on pragmatic principles of a shared code and a shared set of conventions or rules that are unconsciously followed by children and practitioners. Applied to mathematics, this view maintains that with appropriate effort and attention children and practitioners understand each other during teaching and learning interactions. Misconceptions can be identified and corrected, and defined and objective evidence of learning having occurred can be collected.

An integrational linguistic (Toolan, 1996) approach to the role of language in the learning, teaching and assessment of mathematics will also be examined. This approach stems from the principle that no two individuals, child or adult, use language in the same way. Neither do they begin with identical abilities in and aptitudes for language; nor do they base their current learning on identical sets of linguistic prior experience. Relating this to mathematics, no two learners can have identical banks of linguistic resources in mathematics; identical memories attached to the language of mathematics; faculties for learning and processing mathematics and empathy with other individuals engaged in the learning, teaching and assessment of mathematics. As much of this is in the mind, there are issues with verifying the integrational linguistic approach. However, with reference to my previous research and that of others', and also to the work of Heidegger (1962 trans.), the argument will progress to explore the proposition that the language individual children use in learning mathematics will result in them understanding the mathematics taught to them in unpredictably different ways. From this discussion arises a model of the learning, teaching and assessment of lower school mathematics. Critical evaluation of the literature
suggests that elements of all three approaches to linguistics provide an understanding of a bridge of fundamental importance between learner and teacher.

The discussion will then proceed to consider the application of various linguistic approaches to the learning, teaching and assessment of mathematics in the early phases of education. To clarify the context the discussion will begin with a consideration of the nature of mathematics, whether it describes a real and external world or is a mental construct. This is an important question for the practitioner and involves the consideration of learning theory related to an emerging model of learning, teaching and assessment of lower school mathematics. If the world as we see it is real, practitioners merely transmit mathematical facts that are self-evident, eternal and unchanging. Children learn what they are told and re-present what they have memorised as a determinant of achievement. If the world is a mental construct, the approach to mathematical learning is one of personal construction. The practitioner’s task is to guide children so that they individually structure mathematical knowledge according to their personal aims and objectives, understanding, prior knowledge, facility and motivation for the subject. This is a completely different matter, necessitating educators to act as facilitators of developing understanding, as well as transmitters of facts. Educators will know what they have to teach but they have less knowledge of what the individual child has learnt, how s/he has learnt it and what her/his potential is. In both cases, whether positing an external reality or an internal construct, there will also be a social dimension to the mathematics curriculum taught. The relevance of Skinner’s behaviourism (1953), Piaget’s cognitivism (1972), Vygotsky’s socio-cognitivism (1978, 1986 trans., 1987, 2004), Wertsch’s theory of mediation (1985, 1991, 1998, 1999, 2002, 2007) and Meyer and Land’s (2003, 2006) threshold concept theory to the mathematics’ curriculum will be considered. As well as associating the nature of mathematics with the
emerging model, the conclusions from this discussion will be related to national
imperatives on the learning and teaching of mathematics as manifested in
various Government documents and requirements, including The National
Curriculum (DfEE, 1999a), The Curriculum Guidance for the Foundation Stage
(DfEE, 2000), Excellence and Enjoyment: A Strategy for Primary Schools (DfES,
2003a), Every Child Matters (DfES, 2004a) and The Primary Framework (DfES,
2006a).

The next section considers the role of resources in mathematics teaching and
learning in relation to the outcomes of the discussion on the structuralist and
semantic, pragmatic and integrational approaches to language. Variables
contained in the resources used in the classroom are identified and investigated
with reference to brain processing function (Blakemore and Frith, 2005), word
analysis (based on Shuard and Rothery, 1984), Bruner’s (1960) iconic three
modes of representation, and their relationship to language, imagery and the
physical world. This section will consider the role of resources in establishing a
formal system of thought in relation to the emerging model and to threshold
concept theory. This will involve a consideration of current knowledge on the
workings of the brain, learning style theory and the findings of contemporary
research into the role of resources in mathematics education. A model of the
relationship between the external world, resources, language, school
mathematics and threshold concepts will be proposed. Critical evaluation of the
literature will provide evidence for the argument that resources provide visual
imagery mediated by language. This enables learners to traverse the divide
between mathematics as part of the three-dimensional everyday world described
by socio-cultural language, to the two-dimensional abstract world of pure
mathematics described by subject specific language and symbolism.
Assessment and its application to the learning and teaching of mathematics will be the focus of the following section. As will be demonstrated, assessment is a key bridge between the learner and the teacher who is regarded as the embodiment of the subject in the emerging model. Assessment is inextricably linked to teaching and learning, and therefore the placing of emphasis on the teacher, learner or subject will determine the appropriate assessment type to indicate, determine or confirm achievement. In the light of current research, the Assessment Reform Group (1999) initiative will be examined and related to the emerging model and to learning and teaching theory. The implications of assessment for personalised learning as recommended in The Report of the Teaching and Learning in 2020 Review Group (2006b) will also be discussed. Chapter 2 will conclude with the presentation of a model, termed the Learner/Teacher Dynamic, arising out of the literature review of the learning, teaching and assessment of lower school mathematics. It will illustrate how language, resources and assessment function as bridges between learner and teacher.

The methodology arising out of the literature review will be presented in Chapter 3. The focus is on individuality of learners, practitioners and the research school itself within the wider context of lower schools in England and Wales. The overarching methodology adopted is institutional ethnography (Smith, 1987). This research is centred on language and its role in a particular area of the lower school curriculum, mathematics. That there is such an area suggests structure, this being the institutional structure of education. English and mathematics are taught according to The Curriculum Guidance for the Foundation Stage (DfEE, 2000), The National Curriculum (DfEE, 1999a), Excellence and Enjoyment: A Strategy for Primary Schools (DfES, 2003a), Every Child Matters (DfES, 2004a) and The Primary Framework (DfES, 2006a). These are national documents produced by the Government department responsible for education. Success in
their implementation is monitored by Ofsted and published in Government reports and league tables. The normalizing processes and procedures of the institution of education enable a case study on one school to be placed within and related to the wider constituency of schools within England and Wales. A case study approach was seen as appropriate for this research as the focus is on relationships and processes (Denscombe, 2003; Cohen et al., 2005).

Additionally, the in-depth approach afforded by a case study placed within the institutional methodological framework (Smith, 1987) allows the interplay between individuality and structures to be examined in detail. Ethnography was chosen as the appropriate methodology within the institutional approach because it is focused on the individual and his/her relations in the everyday world of the classroom, an appropriate approach to the study of the role of language in the learning, teaching and assessment of mathematics. The resulting institutional ethnography reflected the axiology of the researcher as her ontological and epistemological stances embrace the structured and structuring necessities of social relations, yet recognised an external reality that is comprehended through sense-experience, is extended by science and is understood through individual construction. Specifically for this research and arising out of the findings of the literature review and the ontological and epistemological stance of the researcher, a system of synchronized cameras and audio recorders linked through a mixing technique commonly used in the music industry was created to enable the total recording of lesson interactions.

The research site was a Bedfordshire village lower school with forty-two children between the ages of four and nine years on roll. There are three classes. During the course of the research, the Reception class teacher worked in Class 1 with eight children, the Key Stage 1 teacher in Class 2 with sixteen children and the Class 3 teacher with eighteen children. Two mathematics lessons were recorded
in each of the school’s three classes, the first in November 2006 and the second in March 2007. All practitioners involved and the Headteacher were interviewed using semi-structured interview schedules.

Chapter 4 describes and discusses the qualitative and quantitative analysis of school documentation, content analysis of the interview data, frequency analysis at word level, content analysis at utterance level and discourse analysis at total speech level. Total speech analysis arose from an evaluation of the integrational approach argued by Toolan (1996). It was created in response to that evaluation and the nature of the rich data captured by video and audio devices. In accordance with the ethos of a case study approach embedded within an ethnographic perspective, the use of resources and learner/teacher relationships were analysed as part of the total speech analysis. This was deemed to be appropriate as the use of resources and learner/teacher relationships in the emerging model can only be systematically investigated through analysis of the visual and auditory data. Chapter 5 presents the secondary analysis by placing the various elements of lower school analysis in relation to each other and to the Learner/Teacher Dynamic in order to establish a holistic understanding of interactions. The resulting findings are presented and discussed with reference to key outcomes from the literature review. The Learner/Teacher Dynamic is evaluated in light of these findings and amendments suggested. The thesis ends with the presentation of the conclusions and implications of the research for the learning, teaching and assessment of mathematics in the lower school phase of primary education.
2 Literature Review

2.1 Introduction

In the previous chapter, the stimuli for the creation of a model of learning, teaching and assessment of mathematics were discussed. For the purpose of this thesis, the ‘model’ is defined as a visual representation of processes and relationships to enable reflection and critical evaluation. A preliminary investigation was conducted to determine whether such a model already existed that reflected the relationships and processes perceived between learner, teacher, language, assessment, resources and the socio-cultural environment. If such a model could be found it could be used or adapted to serve as an objective position that could be tested by the literature review and the findings from data analysis. The search was unsuccessful and the researcher was motivated to create a model specifically for this thesis through reflection and critical evaluation of the literature. As will be demonstrated in this chapter construction of the model was influenced by reflection and critical evaluation of some of the models considered in the preliminary investigation. Also the researcher was aware of her own subjectivity in the creation of the model and the carrying out of this study.

The overarching approach taken for this study is ethnographical wherein the self is an integral part of the process of the research and cannot be eliminated from either the process or the findings arising from it (Burawoy, 1991; Hammersley and Atkinson, 1994; Cohen et al., 2005). This demands introspection by the researcher as personal beliefs, experiences and social values may influence the interpretation of events (Smith, 1987; Strauss and Corbin, 1990). As this section discusses literature influencing the process of the creation of a model, it is
necessary at this stage for the axiological position and the ontological and epistemological approach out of which it arises to be made explicit. The axiological position informed the choice of paradigm and the resulting methodologies, the aim being to produce research that has unity and authenticity (Heidegger, 1962 trans.).

2.2 Statement of self

The researcher’s approach to life is determined by a personal perception of the relationship between self and the external world of being different facets of a totality. The self cannot be considered separately from the external world within which s/he thinks and acts. The researcher is mature and has had a variety of experiences in both her home and work lives with which to form this perception. Reflection on these experiences has culminated in a belief in individuals being active in creating their realities. Heidegger’s (1962 trans.) belief that the external world is an individual interpretation resonates with the researcher. So does his perception that recognition and adherence to this individual interpretation gives the existence of being-in-the-world, which Heidegger calls dasein, authenticity. However the researcher retreated from a purely phenomenological approach to this study. Despite a fundamental belief in the primacy of the individual it is recognized that s/he cannot distance her/himself from the social and cultural influences that produced her/him and of which s/he is a part. This, together with the researcher’s role as governor of the school chosen as the research site for this thesis and therefore a member of that community, has resulted in an ethnographic stance being adopted for the current research. The ethnographic stance will be discussed in more detail in Chapter 3 on methodology.

The researcher’s interest in linguistics began as an undergraduate studying history. The names given to places by the first inhabitants and subsequent invaders of this country had meaning. Knowledge of them enabled the researcher
to understand something of the history of places as she travelled. Each word was like the tip of an iceberg with most of its meaning out of sight but nevertheless there. The significance of place names in this country was emphasised during the time the researcher lived in Connecticut in the United States of America. There settlers had imported their home place names from England. The words were the same but the meaning was gone. Lancaster, Connecticut, had at no point hosted a Roman camp. Falmouth was a hundred miles inland. The researcher gained insight into words, from her perspective, that denoted simply on a place on a map and words that reflected the land and its history. This was not, of course, how the inhabitants of Lancaster and Falmouth perceived these place names. For them, the place names had meaning but that meaning was different to that understood by the researcher. This also provided insight.

As mathematics coordinator of a lower school, the researcher realised that her colleagues had problems with the subject. Despite this, the children appeared to learn, as was evidenced in test scores as described in section 1.1. However the researcher noticed whilst analysing these test scores that children were performing less well on data handling questions than they were in other areas of mathematics. This led to a successful application to the then TTA for a grant to research the effect of teacher confidence on the effective teaching of data handling. As part of this research, the researcher realised that the words describing probability, for example ‘likely’, ‘not likely’, ‘equal chance’, were causing problems for the Year 4 children. Out of this insight arose an interest in language and the learning, teaching and assessment of lower school mathematics that has sustained the researcher through her Master’s studies and throughout the course of this doctoral research.
2.3 Language and lower school mathematics

2.3.1 Introduction

The stimulus for the creation of a model of learning, teaching and assessment of lower school mathematics arose from the findings of my Master’s research (Raiker, 2002. See Appendix A) on the relationship between spoken language and lower school mathematics. The model would incorporate a bridge of language between teacher and learner as this was seen as being of great importance. It was suggested that, as well as differing levels of mathematical knowledge and understanding, each individual also has differing levels of ability in and aptitude for language. The argument concluded that, as well as being a bridge to enable teaching and learning to take place, language could prove to be a barrier. How much of a barrier could be determined by the degree of flexibility inherent in language. Language regarded as a mechanistic code-like system where the word has autonomous defined meanings that are related neither to the individuals uttering them nor to the place and event causing them to be uttered is a different proposition in terms of complexity to language viewed as personalised and context-embedded (Chomsky, 1957; Searle, 1979). Applied to the learning, teaching and assessment of lower school mathematics the former normative approach suggests that with appropriate effort and attention children and practitioners can understand each other during teaching and learning interactions; identification and correction of misconceptions would be mechanistic, and unqualified and immediate evidence of learning having occurred can be identified. Arising from the second interpretative approach is the proposition that no two learners of lower school mathematics can have identical banks of linguistic resources in lower school mathematics, identical memories attached to the language of lower school mathematics, faculties for learning and processing lower school mathematics, and empathy with other individuals in the lesson. Therefore the accurate assessment of learning and the identification of
associated misconceptions will be problematic. Both approaches will be examined in this chapter and related to the emergent model.

Howard Gardner’s (1983) contention that mathematical and linguistic intelligences have different starting points will be investigated further as the Master’s research seemed to suggest otherwise. Therefore this review of the literature will begin with a critique of his position, followed by a consideration of the nature of language, and of lower school mathematics respectively. The ensuing review will include reflection upon four linguistic approaches and their implications for lower school mathematics and the model.

2.3.2 Howard Gardner, language and mathematics

Howard Gardner’s (1983) theory of multiple intelligences identified the verbal-linguistic and the logical-mathematical as being two of seven, later eight (Gardner, 1999) distinct intelligences. Although there was overlap between the intelligences, they could be viewed as being distinct as they each met the requirements of a set of criteria. Gardner’s basis for each set of criteria, and indeed for his claim for the existence of an underlying scientific approach, lay in his ‘calling for…sets of intelligences…which meet certain biological and psychological specifications’ in his ‘search for an empirically grounded set of faculties’ (1983:61). He recognised he might fail in his endeavour but believed that ‘the effort should be made to find a firmer foundation for our favourite faculties’ (ibid.). The range and depth of his discussion are impressive, but his referencing is sparse. Despite the copious notes and index of names, Gardner’s work gives the impression of a rationalist and polymath rather than a scientist in search of empirical truth, a Kant rather than a Comte. There is much a priori and little a posteriori reasoning in his argument. Furthermore, Gardner admits that ‘the selection (or rejection) of a candidate intelligence is reminiscent more of an artistic judgement than a scientific assessment’ (1983:62), nudging his theory
away from scientific positivism and further into the realms of interpretative rationalism.

One of Gardner’s key claims was that there is a fundamental difference between the verbal-linguistic and the logical-mathematical intelligences. Gardner’s approach to lower school mathematics and the relationship of language to it is encapsulated by his statement that: ‘In contrast to linguistic and musical capacities, the competence that the author is terming “logical-mathematical intelligence” does not have its origins in the auditory-oral sphere. Instead, this form of thought can be traced to a confrontation with the world of objects’ (1983:128). Then, whilst describing the development of the mathematical understanding by building on the work of Jean Piaget, whom he greatly admired, Gardner states in relation to young children:

> Often at this age, the child can count - that is, he can recite the rote number series. But until the age of four or five, this rote performance-essentially a manifestation of linguistic intelligence - remains removed from his simple estimates of small sets of objects and from his ability to assess the numerosity of a larger array.

(1983:130)

So the child has been confronted with the world of objects and can say the number names in sequence but cannot apply one-to-one correspondence, that is, one name tag to one object. Gelman and Gallistel’s (1978) work provides evidence for this. Gardner suggests in this quotation that a young child can give simple estimates of small sets of objects and assess larger arrays, but gives no evidence in this or later works how this might be so if the child has not been given the words in order to estimate and assess. This is surprising because Gardner’s roles as John H. and Elisabeth A. Hobbs Professor of Cognition and Education at the Harvard Graduate School of Education and Adjunct Professor of Psychology at Harvard University would have given him access to the latest research in cognitive neuroscience. This discipline focuses specifically on understanding
higher processes of cognition using imaging technology such as magnetic resonance imaging (MRI) (Goswami, 2004). Such technology allows the study of the living human brain in action by measuring its effect on local blood flow either directly by positron emission tomography (PET) or indirectly by MRI.

Bruer’s work (1999) has identified the role of the right inferior parietal lobe in mathematical comparison. It appears that this part of the brain is not involved with language. Verbal-linguistic descriptions such as ‘bigger’, ‘smaller’, ‘less’, ‘more’, ‘one’, ‘two’ etc are processed in the left inferior parietal lobe. It would seem that children need to be able to express their three dimensional experiences as words in order to externalize their perceptions. This then suggests that all three dimensional experiences, that is experiences in the world, are fundamentally descriptions and assessments of similarities and comparisons of light and dark, hardness and softness, bitterness and sweetness, loudness and softness, of strong and sweet smells etc. A particular name is then given to that assessment, for example in the blue/red spectrum, ‘lilac’, ‘mauve’, ‘magenta’, ‘purple’ etc. This suggests that the words in lower school mathematics are no different to those describing any other ‘confrontation with the world of objects’, at least, in spoken language. Written language is a different matter. A flower can be described as having five small, lilac petals but only ‘five’ can be further abstracted into the symbol ‘5’. As will be discussed at various points in this thesis, particularly in section 4.4.3 on the relationship between resources and language, brain function and Bruner’s three modes (1960), this has significant implications on the construction of children’s understanding of mathematics.

Another consideration is that the words of lower school mathematics are used very differently from those used to convey the other intelligences, namely verbal-linguistic, musical, logical-mathematical, spatial, bodily-kinaesthetic, interpersonal, intrapersonal and naturalistic. Gardner placed science within and
subsidiary to the logico-mathematical intelligence for the same reason. Because of the nature of lower school mathematics, and that of science, accuracy is given by words having single, precise meanings. In the other intelligences such precision is not necessary. Indeed in literature, multiple meanings, nuances of meaning, tone, pitch, rhythm and register can be rich and essential components of total meaning making. The differing natures and purposes of lower school mathematics and language will now be discussed.

2.3.3 Natures and functions of language and mathematics

Language is a systematic medium whereby humans communicate their thoughts, ideas and feelings to each other. It uses spoken, symbolic and non-verbal forms to convey meaning. In the course of this research ‘symbolic’ means forms of lexical written language and also pictorial and graphic representations. The learning and use of language begins in the earliest days of infancy (Bernstein, 1974; Bruner, 1986; Pinker, 1994) and involves interaction between the child and those caring for her/him. This social dimension to the learning and use of language contributes to the transmission of the specific shared values, beliefs, goals and practices that define the culture within which the interaction takes place. Language cannot be separated from the culture it describes (Bernstein, 1974; Halliday, 1989).

Lower school mathematics is also a systematic medium but has a different purpose. Through the language of lower school mathematics humans recognize, classify, manipulate, normalized and abstract the patterns they perceive in the natural world. Yet perceptions are communicated through language in spoken, non-verbal and symbolic forms. Lower school mathematics has also to be learnt from others, including the language that represents it. Thus lower school mathematics cannot be isolated from the culture in which it is embedded because it is communicated through spoken, non-verbal and symbolic language.
Language, whether linguistic or mathematical, is culturally defined. Gardner (1999) defined an intelligence as being: ‘a biopsychological potential to process information that can be activated in a cultural setting to solve problems or create products that are of value in a culture’ (ibid.:33-34). Therefore a discussion of the role of language in the learning, teaching and assessment of lower school mathematics must include consideration of culture. Various thinkers (Grenfell and James, 1998; Parekh, 2000; Alexander, 2000) have defined 'culture' using similar language to Bolaffi (2003:61), that is as: ‘the body of knowledge and manners acquired by an individual’ and ‘the shared customs, values and beliefs which characterize a given social group, and which have been passed down from generation to generation’. Sfard (2001) characterizes mathematical learning as a process of induction into mathematical discourse, in other words, as part of a process of enculturation into communal practices. Two traditions of thought are normalized in these statements. The first, structuralism, maintains that culture constructs and transfers language and knowledge through a system of signs, the meanings of which are shared and understood within that culture (Bernstein, 1974; Bourdieu, 1992). This confirms the inclusion in the emergent model of language as a bridge of considerable importance.

Furthermore it suggests that the model should be situated in a socio-cultural matrix within which the learner-teacher/lower school mathematics curriculum interaction takes place. Functionalism, the second tradition, postulates that culture is an ideological and political instrument for dictating socio-economic order and stability. This too should be present in the socio-cultural matrix of the model. Therefore the language represented in the socio-cultural matrix and the knowledge that is transmitted by it, for this research lower school mathematics, are both generated to serve socio-cultural needs that include maintenance of the political and ideological status quo. Arising from this is the proposition that the lexography, syntax and semantics of a language are dictated by those in control
of maintaining socio-economic order and stability. This norm of language use is an ideal to which users should aspire and conform (Saussure, 1983 trans.; Gardner, 1983; Pinker, 1994). Sfard (2001, 2008) has observed at length that norms in mathematical language are essential for learners to gain access to the community of mathematics It is argued below that this is the tradition of language known as linguistic semantics, an approach that upholds literal meaning as being predictable and codified. As such it resonates with the subject specific language of lower school mathematics and forms a distinctive mathematical register (Halliday, 1993).

As was indicated in section 2.2, the author’s stance considers reality as a totality. Such divisions as that of structuralist and functional definitions of culture are instrumental necessities in the quest to understand the nature of reality. However, any division causes severing of understanding. An alternate holistic approach is given by Bourdieu in his proposition that one should use one’s understanding to analyse: ‘structures of symbolic systems (particularly language and myth) so as to arrive at the basic principle behind the efficacy of symbols, that is the structure which confers upon symbolic systems their structuring power’ (Bourdieu, 1971:155). In this the subjective and objective perceptions of culture are unified.

As well as being a formal systematic means of communication, language also acts as a ‘vehicle of thought’ (Wittgenstein, 1973 trans.). Once language has been normalized, it can be used to construct personal constructs of reality, the world perceived by the individual. Bernstein (1971), Halliday (1989) and Bourdieu (1990) all comment on differences in language and meaning resulting from diversity. However lower school mathematics has a written form of signs and symbols, for example $5 + 3 = 8$, $\sqrt{a^2} \geq b^2$. Although language may be diverse, mathematical language involving signs and symbols is not. It eliminates diversity.
However this mathematical symbolic written language is based on understanding gained through linguistic processes embedded in real life activity. Taking Halliday’s (1978:16) argument: ‘The construal of reality is inseparable from the construal of the semantic system in which the reality is encoded’, it would appear that an individual’s perceptions of reality are somehow incomplete or undeveloped before the mastery of the semantic system, in this country that of English, is achieved. The implication for lower school mathematics is that unless the semantic system is understood, the mathematical reality embedded within it is incomprehensible. Indeed, there is no mathematical reality without the language to express it because the mathematical language of signs and symbols will be inaccessible. Therefore Gardner’s (1983) contention that the logical-mathematical intelligence is distinct from the linguistic intelligence becomes questionable. Furthermore, it could be argued that the logico-mathematical intelligence is a sub-set of the linguistic intelligence and mathematics a sub-set of language.

Although assessment is considered in depth in section 2.6, the implications of the above for assessment in lower school mathematics need to be stated here. Mental lower school mathematics questions are asked in spoken language. Written assessment questions contain symbolic language and also pictorial and graphic representations. Halliday’s (1978) work, amongst others (Crystal, 1987; Pinker, 1994; Toolan, 1996), demonstrates the differing functions and forms of verbal and especially symbolic language. These play a prominent part in the teaching and learning of lower school mathematics. However written lower school mathematics has a distinct mathematical symbolic written form. Spoken and both symbolic and mathematical symbolic written forms of language are used in the teaching, learning and subsequent assessment of lower school mathematics. If that reality is a construct of language as Halliday believes, then the reality of such tests as the Key Stage 1 SAT for the children taking it is inseparable from the
language that expresses it. In other words if the language in which lower school mathematics is presented is not, or only partially, understood attainment in lower school mathematics will be adversely affected.

There are clearly both socio-cultural and individual components to meaning-making. The discussion so far has suggested that all language arises out of the real life activity of individuals. Language as a system of signs with shared meaning is ideologically and politically structured to maintain socio-economic order and stability (Bernstein, 1974; Bourdieu, 1992; Halliday, 1978). This suggests that a subtext of language is power, and this important aspect of language use will be discussed at a later point in section 2.3.7. It has been suggested that the linguistic semantic approach to language usage enables ideological and political imperatives to be achieved as individuals born into normative social networks are encouraged to conform through the adoption of normative usage, forms and meanings of that language. Vygotsky (1987) called the concepts introduced by teachers in school ‘scientific’. This would be beneficial to effective teaching of lower school mathematics as its language is dependent on totally normative usage, forms and meanings. However there are indications in the above discussion that an individual’s usage of language is never completely normalized because of differences in aptitude, ability, memory and experience. This language expresses everyday concepts (Vygotsky, 1987) from which ‘scientific’ concepts are developed, and then returned to achieve the contextual richness of everyday thought. The following discussion examines structuralist, pragmatic and integrational linguistics to determine how individuals might relate to the language component of the socio-cultural context of the model. The debate will then move to consideration of the application of linguistics to the learning and teaching of lower school mathematics, the resources used during lessons, and assessment.
2.3.4 Structuralist and semantic linguistics

Structuralist linguistics is based on the premise that meanings are the outcome of the differential relationships between terms. It is interesting for this study that Gottlob Frege, known for being the instigator of analytic philosophy and a mathematician, drew parallels between the formal sense of the variables and constants of geometry and the sense of language expressions, thus providing the context from which structuralist linguistics emerged. In section 2.4.3 it will be argued that the perfections of geometry and the logic of mathematics have been imposed on the natural world and therefore do not reflect its reality. Therefore any system of language arising out of such an approach is unlikely to reflect the real-life experiences of individuals. Frege’s work (Mendelsohn, 2005), particularly his dismissal of the mental images that give meaning to language, found resonance in Ferdinand de Saussure’s (1983 trans.) attempts to establish linguistics as a scientific discipline through systematic study. Emphasis was placed on intragrammatical and intersyntactic differential relationships, independent of non-verbal constructs. This logical, positivist approach significantly influenced linguists and philosophers during the twentieth century. For example, Wittgenstein (1973 trans.) and Rorty (1992) both embraced ‘the logic of language’ (Rorty 1992:373) in their early writings, but both moved away from the structuralist position in later life.

Also of importance to Saussure, and consistent with the positivist tradition, is the belief that there is a consensually agreed, unified, objective formulation in language. He writes in the Cours (1983 trans.:30): ‘The individual’s receptive and coordinating faculties build up a stock of imprints which turn out to be for all practical purposes the same as the next person’s’. The emphasis is on similarity, identity and repetition. At the heart of this approach to semantic analysis is the belief that the individual words in a language are endowed with a defined set of denotative meanings. A set of rules is provided to combine them whereby the
individual meanings of the words are merged to form the meanings of sentences. The meanings of these sentences are then combined to form the meaning of speech or text. Speakers use a fixed biplanar code to communicate whereby reified grammatical forms are linked to fixed meanings such as those provided by dictionaries. In reducing language to such a code structuralists, in their abstraction of langue from parole (Sausaure, 1983 trans.) and competence from performance (Chomsky, 1957), distort their very object of study, ignoring its most fundamental role as a medium of communication between individuals in given contexts of use. It is instructive to note that Cobb (2000) and Ben-Zvi and Sfard (2007) reject the view that the process of constructing mathematical meaning for symbols involves associating them with separate, self-contained referents. Instead they identify ways that symbols are used and the meanings they come to have are mutually constitutive and merge together.

The branch of linguistics known as semantic linguistics (Katz and Foder, 1963; Cohen, 1979; Levin, 1977) also studies the relationships between linguistic forms but in addition they study the relationship of these linguistic forms to the world, how words literally connect to things (Yule, 1996). They also try to determine the literal meaning of the relationships between verbal descriptions and events in the world as being true or false, regardless of who is giving the description. Toolan (1996:27) defines literal meaning as: ‘The conventional meanings of words of a language and the meanings of sentences in that language, where any sentence is derived from a complex synthesis of the meaning of its composite words’. Semantic linguists admit that context has some place as background for literal meaning but that this background is too variable to be analysed meaningfully and should be disregarded. As Bakhtin observed:

Linguistics, stylistics and the philosophy of language- as forces in the service of the great centralising tendencies of European verbal-ideological life- have sought first and foremost for unity in diversity. This exclusive ‘orientation towards unity’ in the present and past life of
language has concentrated the attention of philosophical and linguistic thought on the firmest, most stable, least changeable and most monoseic aspects of discourse.

(Bakhtin, 1981:274)

This literalist view of language is therefore objective, constant and makes little reference to context. It suggests that language is a first-order reality that is learned by individuals, not created by them. Such a view of language as comprising of reliable repetitions readily translates into a written vocabulary and grammar of fixed signs signifying fixed meanings totally detached from speakers and events, a "general model of unsponsored language" (Harris, 1989:104). This has its advantages when applied to primary mathematics in terms of fluency, defined by Pimm (1995:174) as: ‘…ease of production and mastery of generation…in relation to a complex system…working with the form’. Such a conception of written language as a metalinguistic abstraction can be understood by considering a first encounter with speech in a foreign language. In an ordinary everyday context, say in a home, a school or a supermarket, such speech will be interpretable to some degree because it is embedded in non-verbal communication and context. The same speech written down would be indecipherable. Higher order mathematics can also be considered a first-order reality in both its verbal and written forms. It exists ‘out there’, is objective and constant. Being an abstraction it can be detached from context. However a central argument of this thesis is that the subject is embedded in context in early years and lower school classrooms. A more detailed discussion of the nature of lower school mathematics, whether it describes a real and external world or is a mental construct, will take place in section 2.4.3. However, to enable clearer understanding of the argument in section 2.4.3 it is necessary to introduce the discussion here in this consideration of approaches to language.

Typically semantic linguists acknowledge context as a necessary frame for literal meaning but maintain that it is neutral and insignificant because language arises
from a shared cultural heritage. Halliday (1993) and Yule (1996) argue that people tend to use language predictably because they are members of social groups and follow general patterns of behaviour expected within the group. Within a familiar social group, we normally find it easy to be polite and say appropriate things. This is redolent of Bourdieu’s (1989) conceptions of *habitus* and field. ‘*Habitus*’ is an internal structure, the totality and embodiment of an individual’s thoughts and experience organised into perceptions of correctness of practices. ‘Field’ is an external structure, the particular reality in which *habitus* finds itself at any point in time. Thus *habitus* is embedded in the shared cultural heritage of which it is a part, so much so that these practices are *habitus*. *Habitus* resonates with Heidegger’s concept of *dasein* (see section 2.2). *Habitus*:

> ....ensures the active presence of past experiences, which, deposited in each organism in the form of schemes of perception, thought and action, tend to guarantee the ‘correctness’ of practices and their constancy over time, more reliably than all formal rules or explicit norms.

(Bourdieu, 1989:43)

Another argument for predictability is the suggestion that the brain is hardwired for extensive syntactic information ready for the attachment of the vocabulary of language. This approach stems from a study of language acquisition begun by Naom Chomsky in his highly critical review of Skinner’s position on verbal behaviour (Chomsky, 1957). Skinner (1953) posited the view that the mind consists of memories of responses to sense stimuli combined together according to straightforward laws of conditioning and reinforcement. The learning that results governs gradual changes in an animal’s behavioural inventory which could be observed. Therefore as language must be learned it must be a behaviour and not a defined part of the brain, or module. Thus thinking must be a form of verbal behaviour since it is the expression of thought that is observable. Chomsky’s counter-argument was that language acquisition theory demonstrates that children learn languages that are governed by sophisticated relationships
between linguistic forms. Without explicit instruction or any other contextual clues as to the nature of these relationships, children in speech apply them in appropriate and well-constructed sequences and in so doing demonstrate competence. However Chomsky’s conception of competence as the speech of an ideal speaker/speaker was narrow, based as it was on his own individual competence as a member of an elite social group.

Chomsky claimed that, through evolution, human biology has enabled the development of an innate, species-specific module that is distinct from general intelligence. He called this module the ‘Language Acquisition Device’ (LAD). Stephen Pinker’s (1994) research into the underlying rules determining children’s language acquisition appears to support Chomsky’s position. He demonstrated that around 18 months children use primitive syntax with two word strings such as ‘All dry’, ‘I sit’ and ‘Airplane allgone’. Pinker noted that children’s two-word combinations were highly alike throughout the world. Across cultures, children pronounce when objects come into view, vanish, and move about. He believes that these word strings already mirror the language being acquired, pointing out that in 95 per cent of these utterances, the words are in the correct sequence.

In contrast Smith’s research (Smith and Hipp, 1994) into the development of his son, Amahl’s, speech involved only partially successful attempts to find linguistic rules. Because Amahl’s speech contained many inaccuracies in phonology and syntax compared with adult speech and missing from the interlanguages of adult learners, Smith concluded that his son was deficient in language ability. However after some years, Smith revised his findings and suggested that the deficiencies in his son’s speech were caused to some degree by ‘varying perceptual discrimination’. As Toolan points out (1996), this further weakens the rule argument as the individuality of the speaker is introduced with all the situatedness this entails. This also throws doubt on Chomsky’s belief that
humans are hardwired for language in the rigid form he suggests, the argument being that Amahl should have spoken phonologically and grammatically correct speech from the beginning. Even Gardner, a proponent of Chomsky, states that no linguist has been able to discover the rules underlying the speech of children (1983:79).

What is more Pinker noticed, following Brown (1973) and Bloom (1993), that children’s two and three word utterances seemed to be fragments taken from longer potential sentences expressing complete and more complicated ideas. He wrote of Brown, noting that although the three children he studied intensively never produced a sentence as complicated as, say: ‘Mother gave John lunch in the kitchen’, they did produce strings containing all of its components that were sequentially correct. An alternate view to LAD theory could be that children learn fragments of sentences and, between the late twos and mid-threes, put them together to form full sentences. These first sentences could then act as templates where words and phrases could be taken out and new vocabulary inserted as required. The emphasis would then be more on memory and mimicry than on the existence of a specific LAD module. This reflects a finding of Wertsch’s (2002) research into teacher-child dyads which revealed how the latter appropriates speech genres from the former. This also supports Sfard (2007) in her contention that effective learning of routines is an essential factor of cognition.

Advances in neuroscience resulting from research on speakers of English have identified the left hemisphere of the brain as dedicated to language and speech, particularly the inferior parietal lobe and parietotemporal cortex. However in right-handed people the dedicated area is more diverse, spreading into the right hemisphere (Blakemore and Frith, 2005). Also Neville et al. (2001) have found that semantic processing activates both right and left hemispheres of the brain; grammatical processing usually takes place in the left hemisphere only. Their
work has indicated that there appears to be a susceptible phase for learning grammar but not for learning vocabulary. The same brain systems are used for learning vocabulary whatever age the vocabulary is learned. These are to be found in the posterior areas of the left and right hemispheres. Conversely, the manner in which the brain deals with grammatical information alters according to the age at which an individual first hears the language. People who learned English as their mother tongue or as a second language between one and three years of age use the left side of the brain when processing English grammar. But individuals who learned English later, usually as a second language, use not only areas in the right hemisphere but also similar areas in the right hemisphere. In fact the older people are when they first hear English the more bilateral the brain’s activity becomes. The evidence from neuroscience therefore suggests that the brain is predisposed to organise the processing and retention of vocabulary and grammar though not in the precise and mechanical the terms that the ‘Learning Acquisition Device’ suggests (O’Shea, 2005).

The implications of structuralist linguistics for the model are that language as a social system of signs can be transmitted to individual children through a highly organized and prescriptive programme of study by the teacher. This suggests that a model of learning, teaching and assessment of lower school mathematics should reflect the primacy of the teacher as transmitter of the curriculum with the learner being dependent on him/her. One configuration of Atherton’s threefold sculpt (2005, online) of teacher-learner-subject reflects this. The threefold sculpt is an arrangement of learner, teacher and subject that denotes priority. An order of teacher-subject-learner would present the pedagogy suggested above where the educator has prime importance because s/he is the repository of all useful knowledge in an area of the curriculum. It is the teacher’s interpretation and delivery of that knowledge that enables the learner to assimilate useful knowledge and present it in a form acceptable for assessment. This pedagogy
reflects a transmissive approach to learning and teaching where subject information is given in lecture format with no opportunity to ask questions on aspects of the lesson which are only partially understood. Lack of understanding is regarded as being due to the incompetence of the learner, and the onus is placed on the learner to rectify that incompetence. This configuration resonates with the structuralist approach to linguistics. This position is in opposition to Vygotsky’s. He argues that ‘scientific’ concepts, that is, concepts taught in school, cannot be assimilated in a pre-determined form: ‘Such a process is pedagogically…fruitless. The teacher who attempts to use this approach achieves nothing but a mindless learning of words’ (1987:170).

Although assessment does not appear in the threefold sculpt, Atherton (ibid. 2005 online) suggests that teaching cannot be teaching without assessment. I would expand that to include the learner also in that the learner cannot learn without assessment. Assessment gives structure to both teaching and learning. It can take place both inside and outside the classroom and be both self and externally motivated. Therefore it is proposed that the terms ‘teacher’ and ‘learner’ should be understood to contain the concept of ‘assessment’ within them. As assessment is common to both learner and teacher it can be regarded as a bridge between them.

The relationship of the teacher to the curriculum and to the learner requires consideration. It has been suggested that the teacher is subsumed by the curriculum. In the introduction to this thesis some of the Government documents driving the lower school mathematics curriculum were presented as part of a discussion of the external factors influencing this study (section 1.4). These legal requirements, together with such internal procedures as performance management, which is focused on attaining high standards of teaching and learning, suggest that the teacher is subsumed by the curriculum. The teacher
will have her/his own teaching style, motivations and abilities in particular areas but ultimately performance is assessed in relation to national standards. Despite this, *ECM* (2003) and *The 2020 Vision Report of the Teaching and Learning in 2020 Review Group* (DfES, 2006b), the driver for the personalized learning agenda, place the learner firmly at the heart of education. Therefore it would appear that the teacher and curriculum could be represented in a model illustrating the learning, teaching and assessment of mathematics as intertwining, subsidiary to and dependent upon the learner at its centre. However, it is acknowledged that the diametrically opposed aspects of Government policy and its associated documentation discussed above are likely to create tensions in the classroom and instability in such a model.

Also, such a configuration with the learner at the centre does not accord with the teacher being the transmitter of the normative, structuralist view of language. On the contrary, a structuralist approach would suggest that the learner takes the subordinate position dependent upon and responding to the teacher and the prescriptions of the curriculum. Teachers will teach language by using a fixed biplanar code to communicate reified grammatical and symbolic forms. The meaning of vocabulary will be fixed through linkage to those provided by dictionaries. The findings of my Master’s research (Raiker, 2002. See Appendix A) that difficulties in the understanding of lower school mathematics involved difficulties with the language used suggest that a structuralist approach to language teaching would be beneficial for learners of lower school mathematics. However, previous discussion has also suggested that context-embeddedness of language is of considerable importance to meaning-making. Therefore it is proposed that a position whereby structuralist theory can be seen as complementing other linguistic approaches when considering the role of language in mathematics should be adopted. This proposition will now be discussed in relation to pragmatics.
2.3.5 Pragmatics

Whereas semantic linguists attempt to determine the literal meaning of the synthesis of the words presented as a sentence, those who adopt a pragmatic approach to linguistics also take into account what the speaker means in the utterance of that sentence. This means that certain aspects of context must be included in the analysis of sentence meaning. According to Searle:

The notion of the literal meaning of a sentence only has application relative to a set of background assumptions, and furthermore these background assumptions are not all and could not all be realized in the semantic structure of the sentence in the way that presuppositions and indexically dependent elements of the sentence’s truth conditions are realized in the semantic structure of the sentence.

(Searle, 1979:120)

For a speaker to be adequately understood the meaning of the words and sentences used must be related to the speech encounter and interaction generated and not simply the lexicon and grammar involved (Gee and Green, 1998). The context given by encounter and interaction will provide insights into whom or what the speech is about and the meanings of the expressions used. For example, the following exchange could be heard and the lexicon and grammar would be understood as being correct. But without information on the background to the exchange what was actually communicated remains unknown:

First girl: Come on, you’re having me on! Did you really?
Second girl: You’ve been there. Wouldn’t you?

The principle behind meaning-making in the example above is that the more two speakers have in common, the less language will be needed to identify familiar things. This principle explains the frequent usage of deictics, words like ‘this’ and ‘that’. These words refer or point to objects in a shared context. Such linguistic pointing is termed deixis. Other relevant factors illustrated in this brief exchange are elements of judgment, cooperation and orientation between the participants,
understandings of the truth of what is being said, sufficiency of information being
given and its relevance for understanding to take place.

So pragmatics combines conventional meaning with context. This is possible
because most people in a linguistic community have similar experiences and
understandings of non-linguistic knowledge arising from a shared socio-cultural
background. This enables participants in a conversation to miss out certain
information because it is assumed that such basic knowledge is not required,
indeed that to include it would be regarded as condescension. A simple example
of this is: ‘Not much of a shower this morning. The head’s clogged up. It was
more cold than hot’. The recipient of this information would be unlikely to question
why the uppermost part of the body is being mentioned or that the experience
was cold more than hot. The giver of the information would assume that the
recipient would make the inference that the shower did not come from the
heavens but from a punctured overhead attachment to vertical pipes connected
to the domestic water supply, that it was heated but the spray was partially
blocked, probably because of a high degree of calcium, in such a way as to allow
only a modicum of hot water to mix with the cold coming directly from the mains
pipes. Semantically, the giver of the information should have included all of the
above in the simple example. Pragmatically, to do so would have seemed
strange to the recipient.

The exchange above was heard and subsequently was written down. In a similar
manner to the semantic approach, the signs on the page, words, are considered
to be signifiers and repeatable indefinitely. The exchange still contains the
assumptions described above which enable certain information to be missed out.
The speaker intended the utterance to be interpreted in a certain way and that is
contained within the written form. However, Derrida argues:
Every sign, linguistic or non-linguistic, spoken or written….can be cited, put between quotation marks: in doing so it can break with every given context, engendering an infinity of new contexts in a manner that is absolutely illimitable.

(Derrida, 1977:185-6)

So although the signs continue to be regarded as iterable, the contexts from which they arise are freely and endlessly variable, an interpretation supported by Bakhtin (1986).

An example of pragmatic speech based on assumptions with similarities to the shower incident was noted during my Master’s research (Raiker, 2002. See Appendix A). The teacher had been delivering a lesson on division with remainders. She wrote each example on the board and then, after the class had solved the problem, wrote the answer in the form ‘x r y’, but used the words ‘left over’ instead of ‘remainder’, omitting the essential information that ‘left over’ was an informal alternative to ‘remainder’ and should be recorded as a remainder.

The following discourse and actions were observed:

Child B: 20 divided by 3 (Takes cubes out of box. Shares cubes into three piles). That’s 6. (Puts remaining two cubes into the box).
Child C: No it’s not. 6 remainder 2.
Child B: It’s only 6. The rest are left over.

(Raiker, 2000:62)

This was the only example observed of implicit assumptions not being picked up by either a child or a teacher during the six observations undertaken. It was observed because Child B externalized his thoughts in words, thus drawing together three essentials in the learning of mathematics- symbolising, communicating and mathematising (Cobb, 2000). Most mathematising remains internalized. This presents the proposition that teachers on occasions use language pragmatically in lower school mathematics, assuming that children will make the necessary inferences to enable leaps rather than small steps towards
understanding. Some children will have the abilities in both natural language and lower school mathematics to make such leaps but others, as in the case of Child B, will not. My Master’s research demonstrated how little open questioning to elicit children’s thinking took place during the six observations but how in group work some children took the role of the teacher in answering queries or correcting misunderstandings. The possibility arises that some children who cannot think pragmatically might leave a lower school mathematics lesson without the small steps being explained and the leaps ending in confusion and misconception. A dialogic approach, whereby children’s answers form the basis and not the end product of their teacher’s further questioning, would address this (Mercer, 2000; Alexander, 2004b).

It is becoming clear that pragmatics embraces both literal meaning and context embeddedness. To recognise ‘logical’ space between them, as suggested by Rorty (1992) in his support of Grice, is useful for empirical purposes but does not reflect utterance in context (Knapp and Michaels, 1985). The discussion suggests that memorisation of sentence fragments (Pinker, 1994) and growing understanding of deictic expression grounded in shared socio-cultural background enable the development of a bank of conventional understandings and expressions that can be personalised and expanded by the individual according to context, intention, truth judgements and abilities.

The implications of pragmatics for a model illustrating the relationships between the learning, teaching and assessment of mathematics are that the socio-economic matrix within which the learner-teacher/curriculum sits contains more elements than originally envisaged. The matrix continues to reflect constant, objective socio-cultural imperatives (Vygotsky, 1987 trans.; Bourdieu, 1990 trans.; Alexander, 2004a), which must be transmitted via the school system and the teacher to individual children through a highly organized and prescriptive
programme of lower school mathematics (Halliday, 1989; Bernstein, 1990; Toolan, 1996). In addition, it now contains the socio-cultural influences on the children. These are subjective, personal and individual. Also there are socio-cultural influences on the teacher of a subjective, personal and individual nature. Both interact with the curriculum but in different roles, the teacher being the ‘expert’ and the child the ‘novice’ (Piaget, 1972). The mathematical language as given by the national strategies will still be present in the lower school mathematics classroom but a pragmatic approach will acknowledge that, in addition, both children and teacher bring their own meanings of words embedded in their own individual experiences to the interaction. This reflects Vygotsky’s general genetic law of cultural development and the primacy of the social in that development: ‘…every function in the child’s cultural development appears twice: first on the social level, and later, on the individual level’ (1978:57). This allows the possibility to arise that problems in the teaching and learning of mathematical concepts by children might in part arise from and be compounded by misunderstandings in the meaning of the spoken language involved and by teachers using language imprecisely and incorrectly. This is a finding of my Master’s research (see section 1.1).

Teachers will be aware that the different backgrounds, or fields to use Bourdieu’s (1990) term, from which their pupils come might influence attainment in lower school mathematics and effective use of its language. Whereas teachers will strive to enable their pupils to attain socially prescribed statutory norms, they will be wary of taking children’s performance in standardised written tests as the only determinant of mathematical ability. Part of this wariness will come from teachers’ understanding that children will assign contexts to the written mathematical questions that may not be intended by the question writer (Cooper and Dunne, 2000). Halliday (1993:39) refers to this as ‘meaning potential’. Teachers will also reflect and evaluate their own performance as well as taking into account the
reports from external inspectors (Earl et al., 2003). The overarching drivers of external regulation and conformity have to be respected. In addition there is a concern with process as well as product based on developing teacher/child relationships enabled through talk. Thus the rigid relationship of the teacher/curriculum to the learner and of the teacher to the curriculum suggested by consideration of a structuralist approach to linguistics becomes more flexible. The learner’s place at the centre of the model becomes supportable. To accommodate the greater flexibility of relationship between learner, subject and teacher in the model, the intertwined strand of teacher and curriculum would loosen with the teacher moving closer to the learner.

As yet the temporal dimension of learning has not been addressed. Introducing the concept of time into the model suggests that continual change is taking place and those changes will be embedded within the language used (Bernstein, 1974). So an individual may use the same word at seven, as a learner, and 27, as a teacher, but the meanings contained in the word will be very different. Wertsch observes that Vygotsky’s: ‘…discovery that word meaning changes and develops is our new and fundamental contribution to the theory of thinking’ (2007:183). This is a finding of my Master’s research (Raiker, 2000). A semantic approach to linguistics reflects the imperatives of mathematical vocabulary in that it must be precise and not open to interpretation. However pragmatics invites exploration of the differences in meaning brought by individuals to speech events and interactions in context. A pragmatic approach to language, therefore, does not reflect the needs of specialist mathematical vocabulary but is essential for understanding in other areas where humans communicate, particularly the arts, media, and social talk (Frowe, 2001).

Another outcome from the discussion is that a pragmatic approach suggests that various forms of language usage should be observable within the classroom, a
space specifically created for teaching and learning (Argyle, 1988; Knapp and hall, 2006). In section 2.4.2 on the socio-cultural background of lower school mathematics there will be consideration of the various Governmental statutory and non-statutory requirements for what children should know and how that knowledge is measured. This discussion will demonstrate how the structures and processes of Government are dictating the structures and practices of the classroom. Such practices arise over time and out of the cultural requirements that produced them, are structured by them, and structure current action and thought.

A culture perpetuates by transmitting its distinctiveness (Bourdieu, 1990 trans.). So the classroom is a space created to transmit cultural practices in perpetuity. Within the classroom there will be evidence of the subject specific language that describes the mathematics curriculum and is grounded in institutionalised socio-cultural imperatives and semantic linguistics (Halliday, 1978). There will also be language that is embedded in the individual and personal socio-cultural background of the child (Bernstein, 1974, Moll et al., 1993). It has to be acknowledged that the process is infinitely more complicated than presented in Figure 1 below and is not linear. Nevertheless, the figure is useful in that it shows the child at the interface of the various influences as an entity, discrete from both familial and institutional structures but integrated within them. The figure also demonstrates Vygotsky’s (1978) general generic law of cultural development, not only his perception of the primacy of the social in human development but also of the inseparability on individual and social. Also Halliday’s (1978) conception of a semantic network whereby semantics is contextualised in a network of social options and characteristics.
Institutionalised Socio-cultural Influences

Government strategies and initiatives, based on national and international, historical, political, and economic and pragmatic considerations

School environment + parental/family involvement + community influence

Leadership of Headteacher and governors

Teacher persona, knowledge and pedagogy

Classroom environment and resources

Peers

A child

Prior learning

Home environment + carer/family involvement + community influence/involvement

Cultural, spiritual, social and historic context of carer/family/community.

Individual Socio-cultural Influences

Figure 1: The teaching-learning interface (cited in Raiker, 2000)

This relationship between the child and the cultural requirements as manifested by curriculum/teacher and classroom is brought together in Bourdieu’s (1989) identification and definition of the interrelated and interdependent *habitus* and field:

The notion of *habitus*...is relational in that it designates a mediation between objective structures and practices... Social reality exists, so to speak, twice, in things and in minds, in fields and in *habitus*, outside and inside agents. And when *habitus* encounters a social world of which it is the product, it finds itself as a ‘fish in water’, it does not feel the weight of the water and takes the world about itself for granted.

(Bourdieu, 1989:43)

The figure above is focused on the child. However a pragmatic approach suggests that there will also be language that is embedded in the individual socio-cultural background of the teacher. This suggests that there will be some
flexibility between the intertwined strand of teacher and curriculum. The teacher will have been trained in the teaching, learning and assessment of lower school mathematics and to some degree its language in the process of acquiring Qualified Teacher Status (QTS). As has been shown by my Master’s research (Raiker, 2000) and confirmed by other studies, many teachers’ grasp of both lower school mathematics and its language is not fully secure (for example Briggs 1993; Sewell 1981; Cockcroft 1982; Briggs and Crook; 1991, Buxton 1981; Raiker & Price, 2000 and Raiker 2002). Therefore there is a tension between teachers’ own mastery of the subject of lower school mathematics and its language, and what teachers are required to teach according to The National Curriculum (2000a), The Primary Framework (2006a) and Mathematical Vocabulary (1999c).

The individual and personal development of a child’s language acquisition is grounded in the close relationship between the child and his/her carer, usually the mother. Bruner, reflecting Wertsch’s earlier work (1985), maintains that the transmission of meaning is rooted in pre-verbal communication which he calls intersubjectivity:

> Intersubjectivity begins with the infant’s and mother’s pleasure in eye-to-eye contact in the opening weeks of life, moves quickly into the two of them sharing joint attention on common objects, and culminates a first preschool phase with the child and a caretaker achieving a meeting of minds by an early exchange of words- an achievement that is never finished.

( Bruner, 1996: 57-58)

The use of the word ‘intersubjectivity’ is important. It suggests the closeness of the dasein of mother and child. For the child, his/her reality is tightly bound up with that of the mother to the extent that for some time the child continues to think that s/he is still one with the mother. The development of the child appears to happen in parallel with a growing sense of separateness, of independence from
the mother. At the same time the child develops language to bridge the gulf of separateness with the mother and also to create relationships with significant others, such as the father and siblings, and also other children and adults as his/her reality expands.

Bruner also points to the ‘joint attention of common objects’ for the ‘meeting of minds’ through words (ibid.:59). Bruner writes generically but he could be discussing mathematical words. The question arises as to the manner in which words stemming from interaction with the world of objects are different from words conveying musical ideas or geographical ideas or mathematical, social or moral ideas. The conclusion appears to be that they are not. Words are encapsulations of distilled experience, organised to varying degrees by the patterns of grammar, and are situated. It is the situatedness that gives words their particular meaning (Mercer and Littleton, 2007; Sfard, 2008). As was discussed above, Bourdieu’s (1989) term for this was ‘field’ and the source of the distilled and embedded experience that manifested itself in words is ‘habitus’. So each individual child builds his/her picture of reality through experiences exclusive to him/her. There will be overlap with the experiences of others. But an individual’s experience will build on those already integrated into his/her being and will therefore be unique. The words s/he uses in language to express those experiences in whatever form, be it rhetoric, mnemonic, explanatory, directive, descriptive, metaphoric, ironic or metalinguistic, will also have unique meanings. The fact that there is overlap of meanings constructed by individuals, a fundamental necessity for communication, should not be taken as evidence that this is sufficient for meaningful understanding to be generated in the classroom, be it in lower school mathematics or any other subject. Halliday (1989) would support this view as he categorised linguistic factors that could cause difficulties for learners. These could be located both within the system of language and also within sociolinguistic language as an institution,
The discussion suggests an approach to linguistics that goes beyond pragmatics. Such an approach suggests that there is no conventional literal meaning, or rather that literal meaning is neither permanent nor foundational but emerges from usage. Literal meanings of utterances of words and sentences are simply representative of the most established and authorized uses of expression arising out of history and power relations. Such an approach would regard every speech event as unique and incapable of being fixed in a biplanar code. This approach would transcend pragmatics in that the emphasis is on the uniqueness of an individual’s total experience manifested in the language used instead of language arising out of shared meaning, embedded within which is literal meaning, acting as a springboard for individual linguistic interactions in context. This approach is known as integrational linguistics and is the final approach to the study of language to be discussed.

2.3.6 Integrational linguistics

The stances of Vygotsky (1986 trans.), Bahktin (1986), Toolan (1996) and Wertsch (2007) are in opposition to those of semantic analysts such as Katz and Foder (1963), Cohen (1979) and Levin (1977), and of pragmatic linguists such as Derrida (1977), Searle (1979) and Knapp and Michaels (1982). At the heart of the work of these theorists is the tenet that the individual words in a language are endowed with a defined set of meanings. Vygotsky (1986 trans.) in particular takes issue with this approach, arguing that humans master themselves through external symbolic and cultural systems, of which language is of prime importance, rather than being subjugated by them. Toolan (1996) confirms this, stating his own view as being: ‘that language should be viewed essentially as other-oriented situated behaviour: but other oriented not at the expense of self-interest but by way of calculated pursuit of reasonable self-orientedness’. In the classroom, such an approach would describe a context of dialogic inquiry (Wells, 1999; Mercer and Littleton, 2007). By other-orientedness, Toolan appears to
mean the need we have as humans to communicate with each other. This is not simply in spoken or written language terms. It is to do with faith, trust, goal orientedness, memory, imagination, intention, relevance and ‘acuity of perception’ (1996:12). Similarities with other researchers’ findings are apparent here as in Bernstein (1990) seeing children’s difficulties at school in terms of interpretation, evaluation and orientation on the part of the child; Wells’ (1990) ‘dialogic inquiry’ in which he updates Vygotsky’s ideas for current classroom interactions; Mercer’s (2000) term ‘interthinking; and Sfard (2007) on children learning mathematics in that she recognizes that semantic usage ignores the experiential aspect of meaning that includes imagery and emotions.

Another term Toolan uses to express this totality of human communication is *ostension*, defined as: ‘behaviour which makes manifest an intention to make something manifest’ (1996:186). This is understood to be the non-verbal behaviour forming a backdrop against which verbal communication takes place. According to Crawford *et al.* (1998) probably more feelings and intentions are communicated non-verbally than through all the verbal methods combined. Ruthrof (2000:1) states that: ‘nonverbal signs are the deep structure of language, and meaning is the event of an association of nonverbal and linguistic signs.’ These researchers maintain that greater recognition should be given to the messages conveyed by body language and non-verbal signals as well as through verbal and written language. Just as a young child comes to understand that the various views of an object, for example the family car, coalesce and are necessary to create an accurate holistic mental picture of that car, so teachers and learners may have to accept that effective communication is dependent on aspects of verbal and non-verbal communication coming together to give meaning and comprehension.
So the concept of context for the integrational linguist goes beyond that of the pragmatist. Whereas the latter acknowledges that literal meaning as expressed in the words and sentences used must be related to the speech encounter and interaction generated and not simply the lexicon and grammar involved, the integrational linguist rejects literal meaning altogether. Speech encounters and interactions are not based on a platform of shared meaning. Shared understandings have to be negotiated each and every time. Individually generated, not socio-culturally generated meanings are supreme. This position would incorporate Bernstein’s (1974) and Alexander’s (2004a) view that the amount of qualitative language owned by a child depends on his/her socio-cultural context. Such a position also gives support to Bakhtin’s (1986:152) approach on questioning that: ‘…if an answer does not give rise to a new question from itself, it falls out of the dialogue’. Bakhtin’s observation reflects Vygotskian thought in that he believes that dialogue is about encouraging children to position themselves within the unending conversations of culture and history. With dialogue comes identity.

From an ethnographic perspective there is much in this perception of individuals being totalities of past and present experiences. However the application of his rejection of literal meaning in language to real life would make writing and the reading of it problematic to the point of impossibility. This has obvious implications for classroom discourse. The fact that humans do want to communicate by writing necessitates current habitualized and normative practice. For example, there are the structuralist silences (Halliday, 1993), that is, meaningful silences that occur instead of speech. A recent example overheard by the researcher involved a friend asking about the health of an acquaintance’s partner, not having the information shared by the rest of the group that the relationship has ended. The resulting silence would indicate there was an issue with that question and that the speaker has committed a *faux pas*, albeit
inadvertently. If shared understandings had to be negotiated each and every
time there could be no such structured silences.

According to the discussion above it can be seen that the totality of what an
individual has been, is, and wants to become is brought to each speech
encounter and interaction. This is a perception that resonates with Heidegger’s
(1962 trans.) *dasein*, the individual ‘being’ (the verb, not noun) in existence or
time. This resonates, in terms of mathematics education, with Sfard’s approach to
discourse in that it encompasses perceiving and doing as well as speaking and
writing. It suggests that strategies encouraging collaborative literacy (Israel *et al*.,
2007), wherein learners work collaboratively in groups using higher order thinking
skills to identify concepts would be helpful in the learning of mathematics.
Language is a necessary means by which an individual develops a deeper sense
of self through social process. This reflects Bourdieu’s (1989) conception of
*habitus* as being an internal structure, the totality and embodiment of an
individual’s thoughts and experience organised into perceptions of correctness of
practices, with the speech encounter being a particular field of correct practices.
However, Bourdieu believes that the linkages between words and objects should
be socially sanctioned so that *habitus* has a shared common means of
communication (Grenfell and James, 1998) with others. This places Bourdieu
amongst the pragmatists.

Heidegger’s ‘authenticity’ embraces the thinking of the writers and researchers
discussed so far in this section, particularly Vygotsky, in that he acknowledges
the fact that the individual cannot distance himself totally from the social and
cultural influences that produced him and of which he is a part. The growth of an
individual, including language development, nearly always takes place within a
socio-cultural context where understanding and knowledge are constructed
through continuous, seamless, social interaction. Unless there are physical
issues, an individual, being a member of a socio-cultural network, cannot prevent himself acquiring sufficient command of language and non-verbal communication to access this shared interaction. This suggests that literal meaning, being a complex synthesis of the socially shared meanings of words in sentences, exists. From a methodological perspective, this means that the socio-cultural context in which individual speech encounters and interactions are observed and collected must be integrated into the analysis.

The implications for the emerging model of an integrational approach is that the socio-cultural context is embedded in the individual, be it pupil or teacher. All aspects of spoken and symbolic language would require continual negotiation out of which shared understandings of meanings would arise. Socio-cultural influences and aspects are seen as being totally individualized. The curriculum would integrate with the learner at the centre of the model with the teacher forming the external strand.

Lower school mathematics as a subject taught through language would be problematic as there could be no shared agreement on the mathematical vocabulary to be used in teaching and learning without negotiation. The results of this negotiation with one individual might differ from another, and another, and another. There would still be lower school mathematics as symbols and as Gardner’s ‘confrontation with the world of objects’ where comparisons would be made and similarities and differences noted. Teachers and the curriculum would move even further from each other as teachers individualized their teaching of lower school mathematics to each learner. This suggests a humanistic approach that is exemplified by the education provided at Summerhill, the school founded on humanist principles by A.S. Neill (Summerhill School, 2004 online). At Summerhill, children choose their own curriculum, when and how it should be taught. In the discussion in section 2.3.4, it was suggested the Atherton sculpt
reflecting the structuralist approach to semantics would be teacher-subject-learner, an integrational approach would suggest a learner-teacher-curriculum sculpt. This is reminiscent of the teaching ethos prevailing at the end of the 1960s and 1970s when teachers could teach what they wanted to teach in a manner and to a timescale that suited them (see section 2.4.2). This has been termed the era of ‘uninformed professionalism’ (Earl et al., 2003). It was brought to a close in the 1980s when an international focus on achievement in language and lower school mathematics raised concerns about teaching and learning methods in these subjects. In particular emphasis was placed on determining the causes of what was perceived as a “long tail of under-achievement” in basic literacy and mathematical skills (ibid.). Out of the ensuing research came The National Curriculum, The National Numeracy and Literacy Strategies and latterly The Primary Framework and the structuralist approach to education that resonates with structuralist linguistics (see section 2.3.4).

2.3.7 Language and power

Discussion in this chapter has explored four approaches to the study of language and its relation to lower school mathematics teaching and learning. One of them, the structuralist approach to language, links words and their meaning through a mechanistic code-like system where the word has autonomous defined meanings that are related neither to the individuals uttering them nor to context of the place and event. It was argued that this approach resonates strongly with the prescriptive, centrally structured and controlled National Curriculum and Primary Strategy. Implicit in this approach is the idea that the location of power lies with the teacher in that the teacher represents the social structure that has produced the mechanistic bipolar system and is the conduit whereby the autonomous defined meanings are transmitted to the learners. As Hasan pointed out; ‘…taking part in discourse is the biggest boot-strapping exercise that humans engage in’ (2005:153).
2.3.7.1 The teacher’s power

What power is, where it is located and how it can be analyzed is a broad field of study. Whilst acknowledging that a deep and thorough discussion on power is beyond the scope of this thesis, nevertheless the concept of power must be addressed as the organization of classroom interaction is based on a system of unequal distribution of rights of discourse between teacher and learner (Edwards and Mercer, 1987; Edwards and Westgate, 1994; Smith, 1999; Thornborrow, 2002). Interestingly, Vygotsky and Wertsch do not give weight to this aspect of learning. However a discussion of power in relation to discourse is necessary. An exchange model of initiation/response/feedback (IRF) has been identified to describe typical actions engaged in by teachers within the classroom (Sinclair and Coultard, 1975; Fisher, 1993). In these typical actions teachers determine, that is have the power to decide, which child will talk, when s/he will talk and for how long, and what s/he will talk about. The word ‘power’ could be interpreted semantically by overlaying scientific connotations of it being something measurable and quantitative onto social contexts of gender, class, race and social status (Lukes, 1974; Hall, 1982). In doing so, power is conceptualized as being ideological and hegemonic. Teachers epitomize the prevailing order of things, natural and unchangeable, even though it may not be in the children’s interests to submit to this order, for example sitting on the carpet when it would be more comfortable to sit on a chair. This approach to power, described by Althusser (1971) and reflected in Bernstein (1990) as a discursive phenomenon, in which discourse operates by constructing specific positions for speaker and listener to occupy, reflects the structuralist and semantic approach to linguistics and hence an appropriate approach to the teaching and learning of lower school mathematics. What is more, Alexander (2004a) has challenged the precept that the organizational aspect of whole-class teaching is more significant for children’s learning than the discourse and values stimulated within that organization. He argues convincingly that whole-class teaching is the commonest approach
worldwide and equally can be connected as strongly with low as with high educational standards.

An approach to power based on fixed positions in discourse such as IRF (Coultard and Sinclair, 1975) has been challenged by post-structuralist theories such as those presented by Bourdieu (1992) and Foucault (1980). Their perception of individuals’ positions in discourse as being multiple and shifting rather than fixed within a particular ideological hegemonic view of the world is more in line with the pragmatic and socio-cultural approaches of Bakhtin (1981), Bernstein (1990) and Wertsch (2002). The concept of communities of practice where language has a symbolic function alongside other symbolic interactionist constructs such as dress codes, body language, proxemic behaviours etc. is encapsulated by Bourdieu (1992) in his term ‘symbolic capital’ which is embodied within *habitus*. However *habitus*, whatever symbolic capital s/he may have, must conform to the rules of the field of the classroom. Here the teacher who represents the ‘educational ideology of the state’ through the institution of the school has control and therefore the power. Foucault’s (1980) argument runs counter to this stance. He disagrees with the view that power should be thought of in terms of dominance and ideology, preferring to conceive it as being ‘a productive network which runs through the whole social body’ (*ibid.*:119), complex and dynamic. He conceptualizes power as a multifaceted and constantly developing web of social and discursive interactions. This clearly resonates with Bakhtin, Bernstein, Toolan and Wertsch. However Foucault also perceives that a society has ‘types of discourse which it accepts and makes function as true’ (*ibid.*:131). The fact that types of discourse can be discerned suggests a degree of normalization.

Evidence for the primacy of the structuralist and semantic approach will be the identification of the three-part teaching exchange of initiation/response/feedback
(Sinclair and Coulard, 1975) in teacher/learner interaction. This is a particular kind of questioning, typical of exchanges in the classroom that differs from the stimulus/response format of the instrumental conditioning school of behaviouristic thought (Skinner, 1953) only in that there is a follow-up response from the teacher. It is interesting to note that there needs to be some form of feedback for the learner to know whether or not s/he have answered the question correctly (Thornborrow, 2002). If this is not forthcoming, or the teacher’s response is ambiguous, the learner will assume a meaning for the lack of response or of clarity. According to Wells and Montgomery (1981) and Fisher (1993), the meaning construed is generally that the learner is incorrect or incomplete in some way. These researchers go on to postulate that such interactions will often result in the learner attempting to discover what the teacher wants to hear and not in the learner focusing on the construction of significant learning.

Also indicative of institutionalized classroom talk where power lies with the teacher are the length of gaps between initiation and response, lack of overlap of talk and the pre-allocation of turn-taking. In a classroom where ‘the locally managed component is largely the domain of teachers, student participation rights being limited to the choice between continuing or selecting by the teacher as the next speaker’, (McHoul, 1978:211), there will be longer gaps between the teacher’s question and the learner’s response than in out of class adult/child interactions. Teachers are encouraged to develop longer wait times between asking questions and choosing a learner to respond (Kyriacou, 1998). This minimizes the possibility of several children talking at once, a component of playground talk (Opie and Opie, 1959; Opie, 1993; Grurgeon et al., 2005), and also maintains the pattern of teacher-learner-teacher-learner etc that typifies classroom exchanges (McHoul, 1978). McHoul also notes that teachers dominate the instructional exchanges in terms of time as they are able to prolong their monologues without fear of interruption. They can also prolong the gaps of
silence. Thus turn-taking becomes asymmetrical with the teacher dictating the pattern of initiation, responses and feedback.

Lower school mathematics is a normalized subject to the point where its systems of entities and operations denoted by symbols can be understood worldwide whatever the mother tongue. The function of a teacher of early years and lower school mathematics is not to encourage difference and diversity in thought but to encourage the acquisition of knowledge and understanding of mathematical facts expressed through its subject specific system of symbols (Pimm, 1995). Therefore an appropriate approach is for power to lie with the teacher. As Fairclough (1992) and van Dijk (1993) maintain power accrues to some participants and not to others and this can result from their institutional role, in this case, whether a participant is a teacher or a learner. Therefore investigating the role of power in discourse will involve identifying who has it and how it is manifested in the language used, in other words, their discourse practices. Approaching the concept of power as a discursive phenomenon will involve focus on manifestations of power ‘at its extremities’ (Foucault, 1980:96). This means observing in detail what teachers and learners say and do in the classroom such as the organization of turn-taking, the turn positions taken by teachers and learners, and the carrying out of certain kinds of speech interactions and discourse manifested in group work.

2.3.7.2 The transfer of power through group work

Group work can be defined as guided participation (Rogoff, 1990), the activity of individuals having defined aims acting in a particular environment. By organising a class into groups, a teacher establishes communities of practice (Lemke, 1988, Israel et al., 2007) that can be encouraged to be self-supportive through interaction. The starting point of group interaction is that all group members know something to do with the purpose of the group (Seifert, 2002; Ben-Zvi and Sfard,
Participation is sustained in relation to shared understanding, developed through the mediation of a common language and appropriate resources (Wertsch, 1990), of particular common practices of the field (Bourdieu, 1990). In this discussion, field is suggested to be the discipline of classroom education and the prescribed attainment targets dictated by national, government-led documentation. Field can also be the group’s location within the classroom. Fields are not necessarily exclusive. In education, fields within fields can be discerned as the group’s location lies within the classroom which is within a school within a local authority acting on behalf of the institution of education which emanates from a government department. Within the context of a lower school mathematics lesson, the speaker’s access to particular kinds of position in talk, and the practical outcomes of discursive resources they might have available to them, will to a large extent be determined by the institution of education as manifested in teacher training, school organization and the Government prescribed curriculum. In such a context evidence of Foucault’s assertion that ‘there are no relations of power without resistance’ and that ‘these are formed right at the point where power is exercised’ (ibid.:142) would be seen to be undesirable.

Some form of teaching will have been part of pre-group interaction, either face-to-face or through technological resource. However, teaching might not be part of the learning taking place in the group work. As Lave (1991:157) observes: ‘Learning [is] taken here to be the first and principally the identity-making life projects in communities of practice’. So in group work, the power inherent in the teacher can be handed over to the group so that individuals as participants can construct their learning, their individual ‘identity-making life projects’. According to Baines, Blatchford and Kutnick (2009), such participation raises achievement.
Following Vygotsky, Bruner (1996:59) points to the 'joint attention of common objects for the meeting of minds' through language and the frequent revisiting of concepts via his metaphor of the spiral curriculum. Precision in spoken language, in class-led discussion and between participants in groups, is of particular importance because talk manifests a subject's genre (Kutnick and Blatchford, 2003; Ben-Zvi-and Sfard, 2007) and forms the principal bridge between teacher/learners and learner/learner. In the mathematics classroom, language enables a cultural model as allows the different sorts of expertise and viewpoints found in a group to be constructed as a resource that any group participant can call upon to inform and guide his/her actions (Gee and Green, 1998). Ben-Zvi and Sfard term the thinking involved in collective activities as 'commognition', being: 'Thinking as individualized communication and school learning as being adept in historically established discourses' (2007:3). This cultural guide is regarded as being dynamic: ‘...not fixed but open to modification, expansion and revision by members as they interact across time and events’ (ibid.:124). This is important for the conception of a model of learning, teaching and assessment of mathematics for this research.

It is essential that the quality of talk is commensurate with the activities generating learning. Quality can be enhanced by making explicit the structure of discourse through the establishment of group rules (Mercer, 2000; Mercer and Littleton, 2007). An example of an appropriate rule is that the views of all participants are sought and considered; another is that explicit agreement precedes discussions and actions. Thus participants first interact on the edge of the community and gradually acquire the understandings and values embodied in language that constitute the community. However, the process reveals a tension between Bourdieu and Wenger. For Bourdieu the setting within which the community of practice operates is a generative infrastructure, whilst for Wenger it is ‘...an emerging property of interacting practices (Wenger, 1990:96). However,
as the inseparability of individual and social is an essential part of both Bourdieu’s and Wenger’s rubrics, the former’s structuring structure which is created by *habitus* is not so far removed from Wenger’s position.

2.3.7.3 Teacher/learner collusion

However Manke (1997) points out that the teacher’s power is not omnipotent. She maintains that teachers have to construct power relations with their learners to maintain their control. Strategies used by teachers observed during her research were politeness tokens such as ‘please’ and ‘thank you’, the use of the inclusive ‘we’ to refer to the class and general statements of school rules instead of reprimands directed at specific individuals. She argues that the objective of these strategies is not simply to decrease the social distance between teacher and learner and develop the latter’s self-esteem. Rather she sees learners being in collusion with their teacher in creating a learning environment where the curriculum can be delivered. Children know they have come to school to learn and therefore acquiesce with classroom rules and behaviours because they recognize these are necessary prerequisites for learning to occur. This suggests that the *habitus* of the learner contains social inheritance (Bernstein, 1974; Robbins, 1993) and that the structure of an individual’s learning is enabled by existing social structures. This is redolent of Bourdieu in his belief in ‘a science of dialectical relations between objective structures…and the subjective dispositions within which these structures are actualized and which tend to reproduce them’ (1977:3). The argument here supports the model as described in the section on structuralist linguistics above with the teacher and subject at its centre and the learner outside and dependent, but with the distance between teacher and learner closing so that the teacher can maintain effective control.

The weight of discussion in this section places power and control overwhelmingly with the teacher. Wertsch (1985) maintains that for higher mental functions to
develop, power must shift from external sources to the individual. Vygotsky (1998b) places emphasis on mediated, social, collaborative activity which suggests a democratic, not autocratic, approach to learning. In today’s classrooms this would manifest itself in teacher/learner interaction and in group work. Whereas the former fits neatly with the concept of the Zone of Proximal Development (ZPD), the latter suggests a looser, more equal, less power-driven collaboration. My Masters research revealed that during group work, different children assumed the role of expert at different times, according to the focus of the talk. Group work can be described by the ZPD process but it has to be recognized that the shift of power within the group setting is subtle and complex.

2.4 Language, lower school mathematics and threshold concept theory

2.4.1 Introduction

The following sections will discuss in greater depth the relationship of mathematics and its language which ‘describes and gives meaning to natural and social phenomena’ (Ollerton, 2006:20). It has been argued that both mathematics and language are abstractions, descriptions and externalisations of what the mind perceives in the external world. The potential and scope for misunderstandings and misconceptions through language will be extended by examining the emerging model in terms of Vygotsky’s (1986 trans.) zone of proximal development (ZPD) and Meyer and Land’s (2006) threshold concept theory to children’s and adults’ difficulties with mathematics. The discussion will be illustrated by the findings of the Master’s research (Raiker, 2000) and also by two preliminary investigations carried out to give direction to this thesis. There will be reference throughout to current and seminal literature on mathematics in the early and lower school phases of education and the difficulties associated with it. Much has been said in section 2.3 about the necessity of setting teaching and learning in its socio-cultural context. For fuller understanding of the issues surrounding the learning, teaching and assessment of mathematics and those
arising from the implications of the linguistic approaches discussed in the previous sections 2.3.4 to 2.3.6, it is necessary to consider the national policies dictating curriculum and practice during recent years. These will be framed by the socio-cultural concerns out of which they arose and which appear to dictate a predominantly behavioural approach to teaching and learning. The physical environment will be considered in section 2.5 on mathematics, language and resources.

2.4.2 The changing context of school mathematics

For the last twenty-five years lower school schools in Great Britain have been constantly engaged in significant educational change, the legacy of apprehension about worldwide economic competitiveness and a perception that Great Britain's status as a world power had declined after the Second World War. Until the 1980s early years and lower school teachers in England had, to a greater or lesser extent, autonomy in their classrooms. They could teach what they wanted to teach in a manner and to a timescale that suited them. This has been termed the era of 'uninformed professionalism' (Earl et al., 2003). However in the 1980s an international focus on achievement in language and mathematics raised concerns about teaching and learning methods in these subjects. In particular emphasis was placed on determining the causes of what was perceived as a 'long tail of under-achievement' in basic literacy and mathematical skills.

The role of Government in education changed and became explicitly interventionist. In the 1980s and for much of the 1990s, the Conservative Government introduced a series of initiatives that attempted to democratise education. At the same time pressure was put on schools to demonstrate school improvement and increasing achievement in return for increased funding. Parents were given greater choice in schools and many aspects of school management were taken from the local education authorities and given to schools. To address
the issues of the long tail of under achievement and on raising standards for low
attaining pupils The National Curriculum was introduced in the late 1980s
(revised 1999), a legal statement of what schools were required to teach. Pupil
achievement was measured by Standard Assessment Tests (SATs) at the end of
each Key Stage at ages seven, eleven, fourteen and sixteen, success in the latter
being awarded by General Certificates in Secondary Education (GCSEs). School
performance was inspected in depth during a round of inspections by Ofsted
beginning in 1996. The shift from teacher autonomy to Government prescription
was compounded by the advent of The National Literacy Strategy (NLS) in 1998
and The National Numeracy Strategy (NNS) in 1999. The aim of the NNS was to
illustrate ‘the intended range and balance of work in lower school mathematics to
make sure that pupils become properly numerate’ (1999a:2). The NNS’s success
would be judged by schools meeting the Government’s target for 2002 that 75%
of all eleven year olds achieve at least level 4 in the tests for mathematics.

There was the potential for much language to be used in the delivery of the NNS
with its emphasis on direct teaching and interactive oral work at both whole class
input and group levels. Directing, instructing, demonstrating, explaining,
illustrating, questioning, discussion, consolidation, evaluation and summation are
all examples of good practice in the teaching of mathematics defined and
described in the document. The oral-mental starter and the plenary, forming the
beginning and the end of the recommended three-part lesson, were intended in
particular to be language rich. A list of approved vocabulary to be introduced
appropriately from Reception to Year 6 was provided in the accompanying
booklet Mathematical Vocabulary (1999c). As the recommended words and
phrases were provided as such and not embedded in exemplar sentences, it can
be argued that the structuralist linguistic approach discussed in section 2.3.4 had
been adopted. This is consistent with the argument developed in that section that
the structuralist approach to linguistics with its focus on denotive meaning was
the most appropriate for the learning, teaching and assessment of mathematics.
Both the NLS and the NNS were piloted by the National Foundation for
online). As the NNS was published a year later than the NLS there was more
opportunity for changes to be made in response to feedback from pilots. Ofsted
inspections continued but with an increasingly ‘lighter touch’. Such a mechanistic
biplanar code-like system where a prescriptive curriculum is assessed by tests
specifically created for the purpose is reminiscent both of the structuralist
approach to language discussed in section 2.3.4 and also of behavioural theory
in the form of instrumental conditioning as formulated by Skinner (1953). This
specialised case of operant conditioning ‘specifies that the subject must perform
the specified acts within the trial situation’ (Jarvis et al., 1998). Although the more
traditional interpretation of operant conditioning allows discovery as part of the
response, in effect the stimulus takes control of the response and therefore the
outcome is predetermined. My Master’s research suggested that teachers
believed they were teaching to allow children to discover mathematical concepts
according to the children’s individual learning styles. In the event the teachers
controlled the methods of children’s learning through the activities they provided
to achieve predetermined outcomes, the mathematical learning objectives
(Edwards and Mercer, 1987; Edwards and Westgate, 1994; Alexander et al.,
1996; Galton et al., 2007).

The emerging model, although seeing the curriculum as tightly entwined with the
teacher, is presented with the learner and not the curriculum as the focus of
education. School knowledge, as distinct from the body of knowledge and
exemplified in the documents above, is selective, organised, normalized and
formalised by the prevailing dominant political presence, and then ritualised to
give the product credibility (Leach and Moon, 1999; Ross, 2000). It does not take
into account the processes involved in personal constructs, orientations and memorised representations of the learner which this thesis is suggesting are far from being linear and discrete. As Leach and Moon (1999) point out, in the USA as well as England and Wales, the question of subject content, subject or disciplinary knowledge can become ‘embroiled in some of the petulant political rhetoric around education’ inviting ‘a continuous polemic associated with the place of disciplines in school reform’ (ibid.:89). This suggests that in terms of socio-cultural requirements, the curriculum’s place should be closer to the centre, if not at the centre, of the emerging model.

Some useful insights for this research on children’s learning following the introduction of the strategies are provided by the major external evaluation undertaken by a Canadian research team based at the Ontario Institute for Studies in Education of the University of Ontario (OISE/UO). Their final Report, incorporating the findings of two earlier Reports issued in 2000 and 2001, was published in 2003. Their brief was to provide an external evaluation of the implementation of the Strategies and not on the effectiveness of children’s learning and understanding. This would have been an impossible task to ask of an evaluation of such a large-scale reform aimed at making differences in the process and product of school and classroom practice at school, LEA and Government level at that point in time. However various indicators on children’s learning did arise from the evaluation that are of interest for this research. The OISE/UO evaluation summarises them in the following paradoxes:

LEA consultants are convinced that the Strategies are having a positive impact on pupils, while expressing concern about teachers not having the capacity to implement them effectively. Teachers and headteachers, on the other hand, believe that they have the necessary capacity but many are not convinced that the Strategies are having an impact on pupils’ learning.

(Earl et al., 2003:109)
The Report does not elaborate on the evidence provided by the LEA consultants, teachers and Headteachers to substantiate their conclusions on the impact of the Strategies on children’s learning. Their brief was to comment on implementation. However the most interesting aspect of this is that whereas the procedures advocated by the Strategies have been embedded in the practice of the vast majority of teachers, the underlying concepts of teaching and learning on which they are based have not. This assessment confirmed earlier work by Cohen and Hill (2001). Their work demonstrated that teachers adopted the behaviours involved in fundamental pedagogical change but did not understand the underlying principles. The result was superficial amendment to practice. Research by Smith et al. (2004) into the pedagogical impact of the National Literacy and Numeracy Strategies revealed that the traditional patterns of IRF interactions had not changed. This confirmed Mercer’s (2000) findings that traditional recapitulation, elicitation, repetition, reformulation and exhortation were dominant in teacher/learners interaction. This is despite the QCA/DfES’s publication of the ‘Speaking, Listening and Learning’ materials.

Again this suggests a mechanistic instrumental behavioural approach to teaching where teachers transmit as instructed, and may explain in part Alexander’s (2004a) argument that there are still concerns about teaching and learning at all levels. This approach puts the teacher and the curriculum at the centre of the emerging model with learners doing as they are told. Teachers were given training in the introduction of the NNS into their practice prior to its implementation but the emphasis was on how to teach the three-part lesson, on planning and assessment, not on assuring teachers’ mathematical knowledge, skills and understanding were at appropriate levels. As has already been discussed lower school teachers teach essential but basic and uncomplicated mathematics involving concepts they would have encountered when they were young children. The findings from research by Raiker and Price (2000) suggested
that the lower school teachers in the study who had problems in teaching the early stages of mathematics acquired these difficulties during their own lower school years.

However, the OISE/UO Report (Earl et al., 2003:128) did suggest that children’s learning and understanding had improved in terms of the attainment definitions contained in the Strategies. Indeed, the evaluation states that ‘Our overall assessment is that increases in pupil learning have been considerable’. Millett et al.’s research confirmed this, concluding that there was: ‘little evidence that factors other than curriculum content, emphasis and mathematical didactics have improved pupil performance’ (2004:187).

But the same paragraph of the OISE/UO Report contains the statement: ‘It is more difficult to draw conclusions about the effect of the Strategies on pupil learning than on teaching practice’ (ibid.). There is no doubt that the introduction of accountability focused through a revised curriculum, target setting, monitoring through Ofsted inspections had focused teachers’ minds on literacy and numeracy. It should be no surprise that teachers’ behaviours changed in response to such conditioning, the result being improvements in attainment as defined by the revised curriculum. Brown and Millett (2003), two of the authors of the longitudinal Leverhulme Numeracy Research Project (LNRP: 1997-2002), confirmed perceptions on the changed attitude of teachers towards mathematics but also pointed out that improvements in the quality of mathematical interactions in the classroom, that is the use of language, was extremely limited. However there is a difference between the outcomes of prescribed learning and embedded, transferable learning as defined as an understanding of mathematical processes. Skemp (1977) recognised these different approaches in his terms ‘ritualised’ and ‘principled’ learning whereas Edwards and Mercer (1987) denoted them as being ‘instrumental’ and ‘relational’ understandings. ‘Ritualised’ and
'instrumental' suggest an emerging model with the teacher/curriculum at the centre; 'principled' and 'relational' suggest a emerging model with the learner at the centre. This confusion whereby a behaviouristic teacher-dominated approach to achieving learning outcomes is contingent on a learner-based approach and not corresponding predetermined learning processes may explain OISE/UT’s inconsistency in conclusion.

An important consideration from the above is that there is more to learning and achieving in mathematics than the implementation of national strategies. Adoption of appropriate behaviours does not necessarily result in fundamental pedagogical change. Nor does the adoption of appropriate behaviours necessarily maximise a child’s mathematical development. Vygotsky wrote:

Research indicates that the zone of proximal development has more significance for the dynamics of intellectual development and for the success of instruction than does the actual level of development.

(Vygotsky, 1986:209)

The zone of proximal development (ZPD) was defined by Vygotsky as being 'the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance, or in collaboration with more capable peers' (ibid.:78 trans.). Children can be helped to acquire the skills and knowledge necessary to traverse this distance through the structured support given by an adult or more experienced others termed ‘scaffolding’ in Bruner’s (1986) work. The adult or more experienced other gradually cedes control and support as the child gains mastery. Therefore the teacher’s knowledge of an individual child’s actual level of development is crucially important as effective learning will be maximised only if the teacher relates current learning to it, being constantly ahead and enabling the way forward. In the real world of the lower school classroom such a personalised approach to individual learning dependent
on one-to-one interactions would be difficult to achieve and maintain. Yet this is the Government’s agenda (DfES, 2004a; DfES, 2006b). It would appear that a practical way forward should have been achieved through group work (see section 2.3.7.2) and effective deployment of skilled and trained teaching assistants (DfES, 2003b).

Houssart’s (2004) work suggests that other factors to be considered are the key variables of appropriate levels of reading and recording skills, and ability to organise work and related materials. Chinn (2004) highlighted the role in effective learning of mathematics of short term memory; mathematical memory involving the recall of facts; understanding of the directionality of mathematics and visual representation; emotion factors and learning style. This suggests an integrational approach to learning reflecting Toolan’s (1996:12) attribution to language learning of faith, trust, goal orientedness, memory, imagination, intention, relevance and ‘acuity of perception’ (see section 2.3.6). Askew, Brown and Millett (2003) suggested that there are four critical elements to effective mathematics learning and teaching: time, talk, expertise and motivation. It would appear that language is just one of many elements affecting the learning and teaching of mathematics. However the variables identified above, apart from time, are all attributes of individuals. The emerging model is concerned with the bridges between individuals that enable children to understand and to learn mathematics over time. Therefore it is argued that there is no inconsistency between the emerging model and the individual variables embedded within teacher and learner identified by the researchers mentioned above and also in section 2.3.6.

In light of such evaluations as those carried out by OISE/UO and LNRP it is not surprising that the mathematics element of The National Curriculum (DfEE, 1999a) is still being reviewed and reissued, the latest document being The Primary Framework (DfES, 2006a). The latter document admits that despite
mathematics being taught for eight years according to centrally dictated
programmes of study: ‘Nearly a quarter of 11-year olds are still not confidently
attaining Level 4 or above in mathematics by the time they leave lower school
school’ (ibid.:2). Level 4 is the level of knowledge, understanding and skills in
mathematics deemed to be appropriate for the average eleven year old to have
achieved. It will be recalled that the Government set a target date of 2002 by
which time seventy-five per cent of all eleven year olds would achieve at least
level 4 in the tests for mathematics. The principal changes to the original NNS in
*The Primary Framework* were definitions of ‘a clearer set of outcomes’, a
‘greater focus upon planning for progression’ and the introduction of ‘a new
electronic format which allows for customised planning, teaching and
assessment, with the ability to link quickly to a wide range of teaching and
learning resources’ (DfES, 2006a:2-3). There has been little change of approach
to teaching and learning from the 1999 documents that have already been
discussed in relation to the OISE/UO and LNRP evaluations. *The Primary
Framework* reinforces a selective, organised, formalised and ritualised approach
to the teaching, learning and assessment of mathematics. Again there has been
training for teachers, and again this has focused on planning and assessment,
not on teachers’ knowledge, skills and understanding. What is more, the high
profile placed on whole-class teaching by the two Strategies and *The Primary
Framework* combined with an emphasis on pace is undermining learners
development of a reflective and strategic approach to learning (Kyriacou and
Goulding, 2004). This confirms the emerging model in that it presents the teacher
as being intertwined with the curriculum being the vehicle for its delivery.

*The Primary Framework* also addresses shortfalls in children’s attainment in
literacy, the ability to use language to speak, listen, read and write (Rose, 2006).
It has already been stated in Chapter 1 that the foci for developments in literacy
are directed at raising standards in writing and in early reading, including phonics.
Speaking and listening together remain a strand within the literacy element of *The Primary Framework* with particular emphasis being placed on developing speaking and listening in the early years. There was no directive or rationale given to practitioners that speaking and listening beyond the early years should be specifically developed. This is despite Ofsted’s (2006:75) findings that speaking and listening were in need of development, but such development would occur naturally in lessons anyway. The emphasis that this thesis places on the understanding of language development as an essential prerequisite for building shared understandings between learner and teacher/curriculum in mathematics education is not reflected in the current directives from Government departments.

### 2.4.3 Mathematics: a mental construct or external reality?

It has been suggested in the discussion above that major issues with the learning, teaching and assessment of mathematics stem from its behaviouristic, biplanar stimulus-response structure and issues concerning teachers’ subject knowledge. That these are still creating difficulties is evidenced by Smith (2004:v) whose investigations into mathematics teaching in secondary schools concluded that: ‘so many important stakeholders believe there to be a crisis in the teaching and learning of mathematics in England’. A definition for mathematics given in section 2.3.3 proposed that it is a systematic means whereby humans recognize, classify, manipulate, generalise and abstract the patterns they perceive in the natural world. Although research such as that by Wynn (1998) has claimed to show that babies as young as six months recognise the difference between two and three objects or movements, the conclusion that this proves that babies recognise number is placing undue weight on the evidence. Such experiments prove only that children recognise difference, not that they comprehend number (Mix, Huttenlocher and Levine, 1997; Mix, Levine and Huttenlocher, 2003).
It has already been argued in section 2.3.1 that all three dimensional experiences, that is experiences in the world, are fundamentally assessments and descriptions of similarities and comparisons. The descriptions of this natural world in relation to mathematics begin with counting as a list of words and pointing so that the words, which are a form of symbol, are associated with the objects to be counted (Liebeck, 1984). The question ‘How many?’ prompts the utterance of the last sound made in the count. The understanding that ‘eight’ is more than ‘two’ occurs because the sound ‘eight’ comes after the sound ‘two’ in a count. Ben-Zvi and Sfard (2007) term this 'object-level learning' whereby the set of known facts is increased and knowledge of the associated subject specific language of mathematics is extended.

The complexities of establishing this seemingly simple relationship between objects and sounds, in other words language, representing number have been researched and disseminated by Gelman and Gallistel (1978). Their work has demonstrated that children learn the number names as word strings that initially do not represent one-to-one correspondence. This is not surprising as the number system from which all mathematics is structured comprises of mental abstractions, ‘the most complete abstractions to which the human mind can attain’ according to Whitehead (1925:49). One can ask a child to look out at the garden and count flowers, birds, trees. There will be many examples of nouns identifying features of the natural world but not of the noun ‘two’. Although ‘two’ can be used as an adjective and is embedded in the external world - there can be two red flowers, two young thrushes, two weeping willows- it is not of the external world. ‘Two’ is initially a verbal description of an abstraction of human creation. Ultimately the abstract system of mathematical language, symbols and operations becomes algebraic, transcending language, culture and geographical boundaries. It would appear from the texts discussed so far that confusions in mathematics might be the result of mathematical understanding beginning “in a
confrontation with the world of objects” in the natural world described by socio-cultural language and ending in abstraction defined by internationally accepted and understood symbols and subject specific language. In other words, in the early stages mathematics is verbal language. This would go some way to illuminate Ben-Yehuda et al’s (2005) perception that there is a distinction between difficulties experienced despite instruction and difficulties that develop because of instruction.

Interestingly, Ben-Zvi and Sfard (2007) argue that mathematics is discourse for older learners. Whereas ‘object-level learning’ occurs when learners have assimilated knowledge about mathematical objects and meta-rules of the genre of the subject and begin to explore by systematically applying those meta-rules to unfamiliar mathematical objects or new meta-rules, for example, investigations involving negative numbers. These only exist in the abstract world, not the everyday three-dimensional world. The only way a learner can access such concepts is through discourse with a more experienced other. So it appears that for both younger and more adept learners, mathematics is language, though the starting points for the two cohorts are very different.

If the perceived world is an external reality, a behaviourist approach to mathematics would be appropriate. Practitioners would merely transmit mathematical facts that are self-evident, eternal and unchanging, a perspective that resonates with the structuralist approach to language. Children learn what they are told and re-present what they have memorised as a determinant of achievement. Gelman and Gallistel’s (1978) research suggests that the mathematical ‘facts’ of one-to-one correspondence, the ordinal and cardinal principles of number, and the stable order and conservation principles of number are far from self-evident. What is more, children are taught to ‘see’ number in the world through language. Houssart (2004:37) appears to support this view in that
she writes ‘the use of vocabulary is hard to separate from the understanding of concepts’. Oers (1997:244) also sees language as the vehicle that ‘gradually moves the child into more abstract forms of semiotic activity. This might be a very important stage in the process towards more abstract thinking especially in the domain of literacy and numeracy’. This suggests that the reality of the world is a personal mental construct and that the approach to mathematical learning should be one of personal construction aimed at understanding socially accepted and confirmed knowledge. This would be the Vygotskian stance (1978) whereby psychological tools such as writing and calculating are used as cultural artifacts which could be used to control behaviour from the outside. The practitioner’s task would then be to guide children so that they individually structure mathematical knowledge according to their personal aims and objectives, learning styles, understanding, prior knowledge, faculty and motivation for the subject. This suggests a similar approach to mathematics teaching and learning as that taken by the pragmatic and integrational linguists to language (see sections 2.3.5 and 2.3.6) and by mathematics educators prior to the advent of The National Curriculum and related strategies (see section 2.4.2). These would support educators acting as facilitators in developing personalised mathematical understanding and not as instruments of ‘indoctrination controlling students’ learning in order to produce the desired results’ (Jarvis et al., 1998).

To close the gap between natural socio-cultural language and subject specific mathematical language, children have to leave behind the exploration of particular instances of the natural world to attain the generalised abstractions of mathematics. In other words, using Halliday’s terminology, language becomes instrumental as it is used for understanding something else. The result is the creation of the genre of mathematics (Sfard, 2001). Consideration of the literature on the learning of mathematics so far has indicated that some individuals at some stages in some areas will not be able to do this without considerable support, if at
all. The implication for the model of this is that the teacher must disentwine from
the socially prescribed curriculum and search for ways to address and resolve the
difficulties of individual learners. In doing so the model will change to reflect that
associated with a pragmatic approach to language.

The discussion in section 2.3 and so far in section 2.4 has established that
language has the potential to create difficulties for learners but has as yet offered
neither solutions to those difficulties nor how such solutions might be resolved.
To be viable the model should incorporate a concept for the resolution of
difficulties that enables not only the successful transfer of mathematical skills and
knowledge from teacher to learner but also their eventual ownership by the
learner to be used as stimuli for continuing autonomous learning. The resolution
of difficulties will now be discussed in relation to Vygotsky’s ZPD (1986 trans.)

2.4.4 Threshold concept theory and language

Although Meyer and Land’s work grew out of research undertaken by the
Economics team of the Economic and Social Research Council’s Teaching and
Learning Research Programme Project ‘Enhancing Teaching and Learning
Environments in Undergraduate Courses’, this thesis proposes that threshold
concept theory may be applicable to the teaching and learning of mathematics
with young children. Meyer’s (2003 online) perception of a threshold concept
grew out of his insight that there were some aspects of subject knowledge that
form:

…a portal, opening up a new and previously inaccessible way of thinking
about something. It represents a transformed way of understanding, or
interpreting, or viewing something without which the learner cannot
progress. As a consequence of comprehending a threshold concept
there may thus be a transformed internal view of subject matter, subject
landscape, or even world view. This transformation may be sudden or it
may be protracted over a considerable period of time, with the transition
to understanding proving troublesome. Such a transformed view or
landscape may represent how people ‘think’ in a particular discipline, or
how they perceive, apprehend, or experience particular phenomena within that discipline (or more generally).

There is nothing in this definition that is not applicable to early years and lower school mathematics. The view expressed here of subject landscape is particularly applicable to mathematics where concepts are interlinked as well as being hierarchical. As Stewart (1996:45-46) graphically expresses it “Mathematics is not just a collection of isolated facts: it is more like a landscape; it has an inherent geography that its users and creators employ to navigate through what would otherwise be an impenetrable jungle”. For example the system of denoting fractions can be used to express the number of parts to its whole, parts of a collection, ratio, proportion, scale, a point on a number line etc. Here children must understand the basic relationship between identical notational features and the different concepts underlying them. However children and adults struggle with fractions, decimals, percentages, ratio and proportion. These areas have different surface features but similar underlying concepts. All of these could be used to represent the same situation, but the appropriate notation has to be chosen for a given purpose. A finding of Askew et al.’s (1997) research into the knowledge, beliefs and practices of a sample of effective teachers of numeracy was that:

…many teachers found it difficult to talk about the links between mathematical concepts which they were teaching in their classrooms. One particular difficult example was that of fractions and decimals, where even the teachers who were best able to discuss the multi-faceted nature and applications of these ideas were still far short of any degree of clarity.  

(Askew et al., 1997:64)

This difficulty could be explained by children and adults not ‘comprehending a threshold concept’, for example that the notational features representing fractions can be manipulated to present the additional but related concepts of decimals, percentages, ratio and proportion. Meyer and Land (2005) state that there are
five defining characteristics of a threshold concept, one of which is that it should bond with other concepts to form a greater understanding of the interconnectivity of ideas. However, it has been argued that mathematics is language for young children. It is therefore proposed that threshold concepts in mathematics for young children are contained in the meta-language bridging the three-dimensional real world, and describing Vygotsky’s (1978) everyday concepts and the two-dimensional abstract world of mathematics, Vygotsky’s ‘scientific concepts’, until the various elements of the symbolic language of mathematics are mastered.

Perkins (1999) terms the confusion, misunderstanding or gaps in understanding as being ‘troublesome’. He applies it to knowledge that is conceptually difficult, counter-intuitive or unknown. ‘Troublesome’ knowledge was identified in my Master’s research, for example when children struggled with equivalence of fractions (Raiker, 2002; Appendix A). It is suggested that incomplete passing through threshold concepts resulting in troublesome knowledge might have contributed to the DCSF’s report on Key Stage 2 SATs results (DCSF, 2007b online) that nearly a quarter of eleven year olds are still not attaining the expected standard of Level 4 in mathematics.

According to Meyer and Land (2006) an individual’s learning at any particular point in time has boundaries. That a threshold concept is bounded is another of the five characteristics defining it. Although Meyer and Land argue that there are multiple points on the boundaries of an individual’s learning where threshold concepts could be located, depending on levels of skills, knowledge, understanding and motivation, it is suggested that with young children thresholds are located in the mathematical vocabulary, Vygotsky’s (1978) ‘scientific concepts’, associated with specified mathematical topic. Gelman and Gallistel’s (1978) work on one-to-one correspondence demonstrates this. Until a child
understands that one number tag corresponds to one object in a sequence, the fundamental concepts of ordinality and cardinality in number are inaccessible to her/him. The child has been told by a more ‘expert’ other the words of counting and that the last number tag denotes the total number in the set, a learning objective in an area of learning beyond current boundaries. S/he cannot go back into the previous state of knowledge because s/he has reached a point in his/her learning, where s/he knows that simply reciting a list of number names unconnected to objects is incorrect. To develop mathematically, the child must cross this conceptual threshold contained in language to develop.

An individual has specific attributes that will enable him/her to cross completely a concept threshold, marking transition into greater understanding in a particular area. This is called preliminal variation by Meyer and Land. Although referring to Cousin’s (cited in Meyer and Land, 2005) comparison between cultural and emotional capital, the constituency of preliminal variation is not identified. It can be proposed that Toolan’s (1996) attributes would not be out of place. These include ability and aptitude in language, linguistic experience, memories linked to words, orientedness to others, and orientedness to the subject being studied (see section 2.3.6). Through language and the access it gives to new conceptual space the individual is enabled to make links with other related understandings, the integrative characteristic of threshold concepts.

2.4.5 Liminal space

Some learners pass over the threshold and embrace the new learning with ease. Others find the new vista ‘troublesome’ and counter-intuitive and may resist the learning opportunities offered because they are meaningless to them (Lather, 1998; Perkins, 1999). A threshold concept may be counter-intuitive, or lead to knowledge that is inherently counter-intuitive. This is another of Meyer and Land’s defining characteristics of a threshold concept. An example would be
children understanding that a two digit number can be greater than a three digit number if the latter is a decimal. In grasping this threshold concept a learner moves from common sense understanding to an understanding which may conflict with perceptions previously regarded as self-evident. They have entered what Meyer and Land (2003 online) term 'liminal space' and can get 'stuck' here. Learners oscillate between the tacit knowledge they have of the new conceptual space and attempted understandings and even misunderstandings of the subject specific language, the subject matter, subject landscape and even world view afforded by the new perspective. It is at this point that the word 'threshold' causes problems. The term 'threshold concept' suggests the passing though or over a barrier whereas the concept of liminality suggests larger areas. As a visual image Meyer and Land's alternative of 'portal' is more appropriate to underline the facility of a threshold concept to open up new vistas of learning and liminality.

Meyer and Land (2005:379) elaborate their perception of a threshold by writing: ‘Thresholds may be seen in this way as leading the learner on through a transformational landscape in a kind of epistemological steeplechase, towards a pre-ordained end’. A threshold would give access to such a transformational landscape but is not one itself. The term ‘threshold concept’ suggests that once the threshold is crossed the concept will be accessed, assimilated and accommodated. It has been argued that this is not necessarily the case. Many teachers found difficulty with mathematics and that these difficulties were transmitted to the pupils they taught. It is suggested that these teachers were still ‘stuck’ in liminal space. They may have accessed the concept by crossing the threshold but were still in the process of accommodating through oscillation as described above. It is suggested that the term 'thresholds to concepts' would more accurately convey the essence of the theory. Also liminal space does not seem to take cognizance of Bruner’s (1960:13) spiral curriculum: ‘A curriculum as
it develops should revisit these basic ideas repeatedly, building upon them until
the student has grasped the formal apparatus that goes with them’.

It is appropriate at this point in the discussion to consider the relationship of
Bruner’s spiral curriculum, Vygotsky’s social cognitivism including the ZPD, and
Piaget’s concepts of assimilation and accommodation to the emerging model of
learning, teaching and assessment of mathematics because they impact on the
evaluation of the concept of liminal space. Bruner believes that children needed
to learn the concepts underpinning subject knowledge rather than facts in order
to be able to transfer knowledge from one situation to another. He maintains that
in the early years children come to understand rudimentary ideas intuitively.

Theorists specializing in the first phase of learning, for example Isaacs (1948),
argue that the beginnings of all concepts arise from sensory-motor exploration
through play and interaction with the real world. Early learning is thus enabled by
informal experiences. Once formal teaching begins in school, Bruner (1960)
argues that any curriculum should regularly revisit taught topics whilst the
knowledge of a subject is expanding. Knowledge is thereby reinforced and
embedded in the widening context. In terms coined by Piaget (1972) this means
that there is a constant dynamic in an individual’s construction of concepts
between them being accommodated as a result of new concepts being accessed
and assimilated by learners. Accommodation means that change to existing
patterns or structures of knowledge has occurred through the process of
assimilation whereby new knowledge perceived by the senses is taken into the
mind. He believes that the teacher has a part to play in guiding and accelerating
learning, unlike Piaget who believes that teacher contribution to enhancing
learning readiness is minimal (1972).

For both these reasons Bruner’s spiral curriculum with its temporal and spatial
dimensions is regarded as particularly significant for this thesis as mathematics
builds on earlier concepts in a hierarchical structure. However, a spiral is a two-dimensional shape. It does not take into account the fact that the learner is assimilating and accommodating learning all the time whilst accessing the curriculum at an increasingly higher attainment level. In order to address the lifelong dimension of learning and the subsuming of earlier mathematical concepts to form the springboard to those at higher levels within the individual learner, it is proposed that the concept of a spiral curriculum be transformed into a helix in the emerging model.

Embedded within Bruner’s concept of the spiral curriculum is the implicit assumption that learners may not accommodate a concept at the first time of teaching but, with frequent revisits, the concept will become eventually embedded in their transformational landscapes. Also in his work he stresses the necessity of scaffolds (Bliss et al., 1996). To recap in education the term ‘scaffolding’, emanating from Bruner’s work (1974, 1986, 1990), is taken to mean the structured support given by an adult or more experienced other to transfer skills and knowledge to a child. Ben-Zvi and Sfard (2007) take the concept further with the term ‘scaffolded individualization’ to denote a fundamental in developing meta-level learning in mathematics. For Bruner, Ben-Zvi and Sfard the adult gradually cedes control and support as the child gains mastery (Vygotsky, 1987). So liminal spaces can be located within the area enclosed by Bruner’s ever-widening spiral and can be regarded as an essential aspect of learning, learners being supported by scaffolds according to the extent of their ‘troublesome knowledge’. As Bruner’s spiral, redrawn as a helix to reflect acquired knowledge absorbed by the learner over time, is an integral part of the emerging model it is argued that liminal space and, by its relationship to them, threshold concepts are both accommodated within the emerging model. Liminal space is thus located between the teacher/curriculum and the learner. It can be equated with Piaget’s assimilation mode (1972) and also reflects Vygotsky’s ZPD
(1986 trans.) whereby ‘scientific concepts’ are developed in the social space between teacher and taught. When the threshold concept has been accommodated it becomes part of the learner’s mental cognitive structure. Whilst in liminal space learners may apply a coping strategy of mimicry where they appear to understand, and may be in the process of acquiring understanding (Raiker 2002; Meyer and Land, 2003 online). Mimicry can be regarded as an aspect the social learning advocated by Vygotsky (1978). However, mimicry in this sense is not parrot-like. Learners appear to be trying through mimicry to learn from those whom they are mimicking, going through the same processes and motions in the hope that ‘the penny will drop’. It originates from novice learners see new information as ‘foreign’ and will practice and appreciate it only because other learners do so (Sfard, 2008). This was observed in my Master’s research (Raiker, 2000) where a boy watched and mimicked others in his group as they folded strips of paper in a fractions lesson to answer questions on equivalence. He did as they did but his answer, unlike theirs, was incorrect. However, whatever position the learner maintains on the assimilation/accommodation continuum (Piaget, 1972), s/he cannot go back through the threshold. Meyer and Land term this the transformative and irreversible characteristics of threshold concepts. The act of perceiving the threshold concept repositions the learner and triggers a transfiguration of his/her identity. The old perceptions are left behind. However the achievement of reconceptualisation and the related threshold takes time. Other children in the mathematics class who are secure in a concept will have moved on. Consideration of the outcomes of current Government policy refocusing on personalised learning linked to progress in terms of enhancing overall and specific achievement would be an interesting area of research to enable insights into threshold concept theory.

Wenger (2000) argued that each subject area and discipline uses particular vocabulary and forms of spoken and written language to communicate its
distinctive perceptions, values and ways of working. Any individual wanting to participate, contribute or engage would need to know the nuances of the subject specific language involved. This resonates with pragmatics but does not take account of the totality of experience an individual brings to a specific subject area and discipline. An individual’s understanding of the language of, say, mathematics, may come from being a member of a socio-economic community of traders, a community of practice such as the classroom or be self-generated through individual interest (Bernstein, 1971; Moll et al., 1993; Cobb and Bowers, 1999). There are also symbolic languages, of which mathematics is an example, and non-verbal language. This wider view accords with Bourdieu’s perception of field, a structured system of social relations at micro and macro levels, and habitus, ‘the product of the embodiment of immanent necessity of a field’, as being ‘ontologically implicit’ (1982:47).

It has been argued that mathematics has a subject specific language but in practice it is highly personalised and non-referential with individuals constructing their own meanings and ways of expression that are only partially related to the context in which they are spoken. Meyer and Land support this view and maintain that extension of specific language is an essential part of threshold concept theory. However they go further in referring to Derrida (1978, cited in Meyer and Land, 2003 online) to make a point that is important for this thesis: ‘Moreover, the inherently arbitrary and non-referential nature of language compounds conceptual difficulty through obliging those seeking to teach or clarify concepts to deploy further terms, metaphors and concepts in an endless play of signification’.

My Master’s research (Raiker, 2002. See Appendix A) involved analysing the range of words used by teachers, children and sample groups during mathematics lessons in six classes. The analysis showed that teachers used a greater range of words when teaching and children use a greater range of words
in teacher-class interactions than in sample group discourse (see Chapter 1 section 1.1). Meyer and Land’s threshold concept theory supports the Master’s finding (Raiker, 2002. See Appendix A) that the greater range of spoken language used by teachers could have been ‘troublesome’ because of the multiplicity of imprecise meanings implied in the words and some children’s inability through inexperience to extract the correct meanings for the mathematical context. This in turn might have hindered some children successfully crossing the threshold theory portal to new schemata of knowledge.

Moreover, once children have begun to master mathematics as a symbolic language they are required to use it to solve real-life problems presented in English. Kelly (2004:54) suggested that if children are to use mathematics effectively in the real world they should be encouraged to ‘focus on expert performance; understanding and solving problems; engage in creative action and skilful tool use; work with pride; and share responsibility for their learning in collaborative groups’. The review of literature does not argue against any of these aims but suggests that lack of emphasis on the role of language in developing and externalising them is an important omission.

A preliminary investigation to the main research to this thesis indicated that proficiency in mathematics is dependent on proficiency in language. To gain insight into possible relationships between competencies of lower school children in language and mathematics a search was made of the Ofsted website. The latest reports of the 148 lower schools in the Bedfordshire LEA prior to 2004 were examined. Of these 134 lower schools listed the results of their most recent SATs in reading, writing and mathematics at Key Stage 1 at the time of their reports. These results were displayed as pupils achieving level 2 and above in terms of percentages. Also given were national expectations for each subject again as percentages.
In order to analyse the data the variance of the scores of individual schools from national expectations as percentages was calculated; for example if the school’s score in reading was 84% and the national expectations was eighty per cent a variance of plus 4 per cent was recorded. This was done for scores in reading, writing and mathematics. These variances were sorted according to the scores in mathematics and then displayed as a bar chart (Appendix B). The results suggest achievement in writing and reading are related to achievement in mathematics. In other words competency in the specific subject of mathematics, established through discussion of the literature as being language dependent, is predicated on a wider competency in language. However, no research was undertaken at the time to determine the possible reasons for this. Subsequently a further preliminary investigation was carried out to determine whether any particular format of written mathematical questions was more or less problematic for learners. This research will be discussed in Section 2.6 on assessment and mathematics.

2.4.6 The mathematics teacher’s role

The mathematics teacher’s role in resolving difficulties is to discover the epistemological obstacles preventing individual learners from transforming their learning. Young-Loveridge and Taylor’s (2005) study of nine to eleven year olds in New Zealand demonstrated how difficult this might be as some of the learners studied had deep seated and erroneous beliefs about the learning of mathematics which they were reluctant to abandon. Meyer and Land advise educators to embrace the praxis of liminal space, and to encourage and signpost independent learning until learners have crossed the new conceptual space to approach further threshold concepts. Their thinking here reflects Vygotsky’s ZPD with educators being scaffolds (Bruner, 1986), the aim being to transfer mastery from educator to learner, thus enabling the latter to be autonomous. According to Yackel and Cobb:
...students who are autonomous in mathematics are aware of, and draw on, their own intellectual capabilities when making mathematical decisions and judgments as they participate in these practices...These students can be contrasted with those who are intellectually heteronomous and who rely on the pronouncements of an authority to know how to act appropriately.

(Yackel and Cobb, 1996:473)

Because of the emphasis on language in mathematics and the social-cultural context in which it is internalized and practiced before becoming part of thinking, the mathematics teacher should also encourage collaborative literacy for mathematics in the classroom. This means designing activities in which learners actively use their mathematics skills and the associated subject specific language in contexts appropriate to the level of their knowledge and understanding (Israel et al., 2007). This in turn suggests that mathematics teachers could collaborate with each other and with other colleagues in school, learners and their families to develop a shared epistemology regarding the learning and teaching of mathematics (Snell et al., 2005).

As epistemology arises out of ontology, in doing so the teacher is also facilitating a child’s ontological world view. Though they are writing generically and not specifically about mathematics, Meyer and Land (2005) confirm the emphasis placed on the role of language in this process. They also extend the discussion to suggest that language is a necessary constituent of the ontological repositioning of the learners resulting from their attainment of threshold concepts:

We would argue further that as students acquire threshold concepts, and extend their use of language in relation to these concepts, there occurs also a shift in the learner’s subjectivity, a repositioning of the self. What is being emphasised here is the inter-relatedness of the learner’s identity with thinking and language. Threshold concepts lead not only to transformed thought but to a transfiguration of identity and adoption of an extended discourse.

(Meyer and Land, 2005:374)
This can happen in any subject but as has already been argued, the learner of mathematics has to move from rational understanding based on describing the outcomes of everyday concepts (Vygotsky, 1987), gleaned from ‘a confrontation with the world of objects’ (Gardner, 1983:128), to the idealism of mathematical abstraction which involves operations on symbols and logic. This involves a shift in language use from descriptions of the real world, which provides context, to a precise and prescriptive use of language in order to make statements which are formulas or descriptions that can be expressed in the language of mathematical symbolism. Particularly in the early stages, children have to double decode in a similar fashion to adults learning to speak a foreign language. Spoken mathematical words must be decoded in the initial context of language usage and then translated into the different context of mathematical usage. Double decoding also occurs firstly when written mathematical words or symbols are first encountered, and then when connected to a concept that may or may not be part of the learner’s prior knowledge (Barton and Heidema, 2002). Then, once children have begun to master mathematics as a symbolic language they are required to use it to solve real-life problems presented in English. The difficulties inherent in this have been discussed fully in this chapter so far.

The argument so far has demonstrated that problems in mathematics could arise as children pass from the socio-cultural language describing the real world to the mathematical language system describing the generalised abstractions of mathematics (see section 2.4.3). It has also been argued in sections 1.1 and 2.3.6 that for this to happen without difficulty teacher and learners must share some degree of literal understanding to allow sufficient literal meanings to form a springboard for language development and for instruction to develop psychological function (Vygotsky, 1987). This is embedded within shared socio-cultural non-verbal signals and results in the construction by teacher and learners of a ‘common knowledge’ to allow the transfer of mathematical knowledge to take
place (Edward and Mercer, 1987). Using what Ellsworth (1997:71) calls a ‘third ear’, the teacher’s task is to look beyond the appearance of a learner’s knowledge to identify, through effective assessment based on constructive feedback, the roots of these epistemological obstacles, reveal the misconception or blockage to the learner and re-teach so that it is removed. Interestingly, Meyer and Land (2005:381-382) warn against the use of scaffolding, which they regard as: ‘a naïve version of a threshold concept (in that it is a deliberately simplified and limited delineation)...to act to a certain extent as a proxy for the threshold concept’. Bruner developed Vygotsky’s ideas so it is not surprising that the concept of scaffolding, the traverse of subject landscape from the onset of a task to mastery, reflects Vygotsky’s Zone of Proximal Development. For Vygotsky and Bruner a child’s mastery over skills and knowledge appeared to unfold as a socio-cognitive process, as it were from bud to bloom, with the care, attention and support of the scaffold.

Meyer and Land’s interpretation of scaffolding appears to disregard the fundamental concept being expressed here of gradual coming into knowledge within a subject landscape. However, oscillation within a subject landscape is a key feature of liminal space. It appears that for Meyer and Land a learner either crosses a concept threshold or is caught in liminal space, bedeviled by troublesome knowledge. The difference in perception may reflect differences in learning between students and pupils. As confusion and anxiety accompany misunderstandings and misconceptions in mathematics (Raiker and Price, 2000; Raiker, 2002), it appears that Meyer and Land’s theory is closer to what learners experience than Bruner’s and Vygotsky’s, at least in mathematics in the lower school phase.

Various remedial mathematics programmes, such as the Springboard series (DfES, 2004b online) and the Interactive Teaching Programs (DfES, 2006d...
online) present sequences of scaffolded and recursive activities to be used socio-cognitively (Vygotsky, 1986) so that reconceptualisation can take place and learners are enabled to pass over the threshold to new concepts. However, the problem may be that the learner has insufficient knowledge to progress and is not ‘ready to learn’ in Piagetian terms (Piaget, 1972). Meyer and Land (2006) use the metaphor of a chess game with a player developing a piece by eliminating others to give access to a choice of further moves all focused on an objective, checkmate. In a similar way the obstacles of misconceptions and lack of knowledge are removed so that new possibilities become accessible, focused on achieving mastery of mathematics. However this did not appear to be happening in lower schools during the period between the publication of the NNS (DfEE, 1999b) and The Primary Framework (DfES, 2006a). The NNS endorsed whole class teaching as active teaching, promoting high-quality dialogue and discussion between teachers and pupils. Pupils were expected to play an active part in discussion by asking questions, contributing ideas, explaining and demonstrating their ideas to the class, reflecting Alexander’s (2004b) approach to dialogic teaching. Yet Smith et al. (2004), confirming the findings of Mroz et al. (2000) and Kyriacou and Smith (2008), found that teachers spent the majority of their time explaining or in using highly structured questions and answers of low cognitive level designed to direct learners’ responses towards the required answers corresponding to Mercer’s (2000) reformulation and elicitation modes. This type of oral exchange does not stimulate or advance children’s thinking.

It would appear the teachers of mathematics should understand that prescriptive measures can take the learners only so far, because of the broadness of student engagements and their personal attributes but also because of the power inequalities inherent in an education system driven by assessment and a behaviourist, stimulus-response approach to teaching (see section 2.3.7). The construction of ‘common knowledge’ (Edwards and Mercer, 1987) in which the
teaching and learning of mathematics is embedded is one-sided (Sinclair and Coultard, 1975; Smith, 1999, Thornborrow, 2002). As Grenfell and James (1998:80) succinctly write: ‘the teacher constructs an “ideal pedagogic subject” to which she operates and wants pupils to conform’. The teacher has power in the mathematical linguistic field of the classroom and her mathematical linguistic *habitus* is dominant (Fairclough, 1992). As each pupil comes with cultural and linguistic capital the consequences of this are, as demonstrated by Bourne (1992), that certain pupils are excluded from the opportunity to access threshold concepts in mathematics or exclude themselves, consciously or subconsciously but through their behaviours, responses to the power differential, and interaction with their peers. Halliday (1989), reflecting upon Bernstein, observed this also. Excluded, pupils have only their own *habiti* to fall back on. Thus classroom practice is legitimate for one group of pupils who reflect the teacher’s mathematical *habitus* and have thus greater opportunities to access threshold concepts, whilst being in opposition to others which are considered unorthodox by the first group but are in fact legitimate.

Within this prescription there are clearly issues of hierarchy and relations of power that are creating further obstacles to mathematical learning. As Meyer and Land point out:

> It might, of course, be argued, in a critical sense, that such transformed understanding leads to a privileged or dominant view and therefore a contestable way of understanding something. This would give rise to discussion of how threshold concepts come to be identified and prioritized in the first instance.

(Meyer and Land, 2003 online)

However, unlike such subjects as history or English literature, there is a greater possibility of identification of threshold concepts because there is greater consensus on what constitutes a body of knowledge. Also, because of the subject content of mathematics and its emphasis on logic, the difficulties of
threshold concept theory seeming to normalize such curricula as English literature, history or economics according to an external agenda in the Foucauldian sense (Foucault, 1980) does not appertain. As has already been argued, for young children at the outset all concepts in mathematics are core concepts as they are foundational. Discerning points where they become threshold concepts would be an interesting and useful area for further research.

2.5 **Language, lower school mathematics and resources**

2.5.1 **Introduction**

Resources were identified in section 1.2 as a potential bridge between the learner and the teacher/curriculum. Additionally, Vygotsky (1978) argues that appropriate cultural tools and artifacts with which to think were essential to creativity, in other words, for meaningful and productive learning. In the broadest sense, resources are the principal learning tools from which a learner actively seeks the knowledge they choose to explore through experimentation, investigation and interaction (Powell, 1991; Drews and Hansen, 2007). Pollard (2002) reflecting Rivlin et al. (1995) widens the definition, stating that resources in education include people, building, equipment and materials. This includes the physical layout of the classroom and contents such as displays, pencils, interactive whiteboards, computers, appropriate books, light, temperature etc. Pimm’s view (1995) reflected in Cobb et al. (2000), widens the definition in a different sense, stating that all language and manipulatives can be regarded as metaphors in mathematics. Whilst acknowledging understanding of this perspective, adhering to such a definition whilst attempting to relate linguistic approaches to the use of language in primary mathematics is unhelpful.

In section 2.3.5 the classroom was identified as a ‘field’ in which the ‘habitus’ of learner and teacher interact and relationships are formed (Bourdieu, 1989). Although *habitus* and *field* can be separated so that their distinctive elements can
be identified and evaluated, in reality they are different aspects of the same unity:

The notion of habitus...is relational in that it designates a mediation between objective structures and practices...... Social reality exists, so to speak, twice, in things and in minds, in fields and in habitus, outside and inside agents. And when habitus encounters a social world of which it is the product, it finds itself as a 'fish in water', it does not feel the weight of the water and takes the world about itself for granted.

(Bourdieu 1989:43)

The field of the classroom is the common and shared context within which the social relationships between learner and teacher, and between peers, take place. This includes physical resources, such as two and three dimensional shapes and number lines, which are an integral part of current mathematical practice.

However habitus confirms the individuality of learner and teacher. All individuals will come from fields outside of the classroom that differ. So both learner and teacher will come to the field of the classroom with internalised structures that will have only partial congruence with it. With regard to mathematics, learner and teacher will come to the field of the mathematics lesson with internalised mathematical structures that will only have partial congruence with the lesson taught. Ability in and aptitude for the subject and its recall, and prior experiences and levels of understanding will be different for each individual in the mathematics lesson, teacher and learner. Nevertheless the degree of that partiality has to be sufficient for knowledge and understanding to be transferred through the structure of the lesson. Resources as cultural tools (Wertsch, 1998) have an essential role in this process.

Resources also include teachers, learning support assistants, parent helpers as well as the children themselves (Pollard, 2002). Learners are resources because they bring into the learning community their own beliefs, experiences and knowledge. They also act as resources when they give verbal feedback to other pupils as part of self-assessment. Thus there are many areas covered by the
term ‘resource’. Detailed examination of all areas is impossible in a thesis of this length so discussion will be confined to the first definition offered by Drews and Hansen (2007), namely that resources are the principal learning tools from which a learner actively seeks the knowledge they choose to explore through experimentation, investigation and interaction. It is proposed that people should be discounted from this discussion because they cannot be regarded as tools. Evidence from my Master’s research (Raiker, 2000) indicated that the principal learning tools actively sought in a mathematics lesson were the manipulatives provided by the teacher though Pimm (1995) also sees images as significant for the learning of mathematics. Group activities were constructed round the manipulatives available in the school and were seen as a fundamental component of the daily mathematics lesson. Therefore the discussion in the following sections will focus on manipulatives, being ‘objects designed to represent explicitly and concretely mathematical ideas that are abstract’ (Moyer, 2001:176) and also address images, particularly in consideration of the transfer of three-dimensional real world objects into two-dimensional abstractions.

2.5.2 Brain function, language and resources

It has already been argued in section 2.4.3 that mathematics, like language, is embedded in the external world but is not of the external world. In other words humans have created in mathematics: ‘a formal system of thought for recognizing, classifying and exploiting patterns’ (Stewart, 1995:1) that is: ‘biased, finally, to project onto physical phenomena an anthropocentric framework that causes all of us to see evidence for design where only evolution and randomness are at work’ (Deheane, 1998:252). The following discussion will consider the role of resources in establishing that formal system of thought in relation to the emerging model and to threshold concepts. This will involve a consideration of recent knowledge on the workings of the brain, learning style theory and the
findings of contemporary research into the role of resources in mathematics education.

Neuroscience is a relatively new field of study. It is concerned with “the study of the nervous system and brain, and the biological basis of consciousness, perception, memory and learning” and “draws on information from biology, psychology and social and cultural studies” (Toplis cited in Zwardiack-Myers, 2007). As it is relatively new it is therefore subject to disagreements, claims and counterclaims as the discipline evolves. Therefore findings from neuroscience have to be regarded with some degree of professional skepticism (Bruer, 1999). Nevertheless, magnetic resonance imaging (MRI), which views the structure of the living brain and its activity when individuals engage in tasks, and positron emission tomography (PET), which measures blood flow in the brain, have provided insights into how the brain works in a multiplicity of ways, including how it learns and processes information (Goswami, 2004). Of great interest to this study is the knowledge gained through such techniques that the right and left side of the brain have different functions and this may explain why resources have a role in enabling an individual to move from the external world described by socio-cultural language to that of the abstract world of mathematics defined by symbols and subject specific language.

It was argued in section 2.3.1 that essentially all individual experiences in the external three-dimensional world are personal comparisons of similarities and differences perceived by the senses. The brain evolved in the three-dimensional world and the parietal cortex has been found to be significantly implicated in visualizing where things are in it (Blakemore and Frith, 2005). Spatial representation as it is termed is therefore essential to function in everyday life. Findings from neuroscience have identified that the right inferior parietal lobe is engaged in mathematical comparison (Dehaene, 1998). Deheane has also
suggested that the physical or visual representations that are involved in mathematical comparison are important in enabling humans to create mental images including numerals that allow the conversion of quantity in three dimensional space to its representation in symbolic two-dimensional form once subitizing, the visual quantification of number, fails. This occurs with increasing incidence of error from three onwards and with numbers that are close together. Dehaene (ibid.:68) concluded that: ‘subitizing in human adults, like numerosity discrimination in babies and animals, depends on circuits of our visual system that are dedicated to localizing and tracking objects in space’) and that:

…the adult human brain, whenever it is presented with a numeral, rushes to convert it into an internal analogical magnitude that preserves the proximity relations between quantities. The conversion is automatic and unconscious. It allows us to retrieve immediately the meaning of a symbol such a 8- a quantity between 7 and 9, closer to 0 than to 2, and so on. (Ibid: 86-87)

It appears that comparison of quantities occurs in the part of the brain that is not involved with language. The findings from research in neuroscience on the relationship between brain functioning and structuralist semantics, particularly on the potential for the existence of a language acquisition device (Chomsky, 1957) were discussed in section 2.3.4. Verbal-linguistic descriptions such as ‘bigger’, ‘smaller’, ‘less’, ‘more’, ‘one’, ‘two’ etc are processed in the left inferior parietal lobe (Pinker, 1994). Also located in the left parietal lobe is the ability to perform exact calculations (Barth et al., 2005). Barth et al. demonstrated that exact calculation is dependent on language, whilst approximation relies on nonverbal visual and spatial networks that are located in the right hemisphere of the brain. The authors link rote learning of, for example, multiplication tables, with the verbal system and approximations of quantity with the visual-spatial system. Interestingly, Neville and Bruer’s (2001) work has found that grammatical
processing occurs in the left hemisphere only, whilst semantic processing, that is words and their meanings, activate both hemispheres at the back of the brain. This suggests the area responsible for semantic processing has some function linking the right brain with its capacity to process visual-spatial information and the left hemisphere that deals with abstractions. Thus neuroscience confirms the Vygotskian view (1986 trans.) that teaching as part of formal schooling is not a mere developmental facilitation as Frith and Blakemore (2005) have suggested, but a higher order cognitive activity that requires conscious effort and direct intervention.

Consideration of the above suggests that for children to extract mathematics from the external three-dimensional world to the abstraction of calculation, they have to develop the language function of their brains. Resources have a key role in this in that they provide visual/spatial representations of mathematics that can support children in their development of the mental imagery underlying mathematical abstraction, and can stimulate appropriate language (Johnson-Laird, 1983). Papers presented at the 2007 British Education Research Association conference by Murphy on English and Dutch approaches to teaching calculations using empty number lines, and by Barmby on research into the use of array representations and lower school children’s understanding and reasoning in multiplication, confirmed this. However, as Cobb (2000) points out, a number line is not a prototype for integers. Learners must find ways of interpreting number lines before they have mathematical meaning.

Such an interpretation of the literature reflects to some degree Bruner’s (1964) three modes of representing experiences. The enactive mode involves some form of action in the external world that includes the manipulation of physical objects, the iconic mode involves representing those ideas using pictures and images, and the symbolic mode representation through language and symbols.
However, whereas Bruner places physical objects in his enactive mode, the discussion above envisages them in a transition zone that equates to his iconic mode. This is because manipulatives can be seen as having two forms. The first form is as objects in the external world. The second is as ‘objects designed to represent explicitly and concretely mathematical ideas that are abstract’ (Moyer, 2001:176; Mooney et al., 2007) and are not to be found in the everyday world, for example Dienes (Multibase 10) apparatus or multilink cubes used in place value and pattern work. The first is congruent with Bruner’s enactive mode. It is proposed that the second fits more readily into the iconic mode (see below). All three modes stimulate and involve the use of language and all depend on the collective and interactive environment that classrooms offer (Alexander, 2004b)

Bruer’s two forms of those to be found in the real world and those in the mathematical world resonate with Heidegger’s (1962) approach to categorical determinations. The concept of *dasein* contains the precept that all things external to it, categories, can be either ‘things at hand’ or ‘things objectively present’. The determining factor between the two is the evidency of their purpose. The purpose or ‘handiness’ of ‘things at hand’ is known to *dasein* whereas that of ‘things objectively present’ is not. ‘Things objectively present’ may or may not become ‘things at hand’. For example, a child will come to know by trial and error that Unifix cubes can be pushed together to make towers and are therefore ‘things at hand’. Unless s/he is taught, Unifix as a resource for enabling the concept of place value will always remain a ‘thing objectively present’ and will never become a ‘thing at hand’, handy for the purpose of specific understanding.

As has already been discussed in Chapter 1 and subsequently, multiple interpretations of words used by teachers in mathematics lessons could cause confusion in children’s minds. My Master’s research (Raiker, 2002. See Appendix A) used Shuard and Rothery’s (1984) categorisation to analyze the types of
words used by learners and teachers in mathematics lessons. Their findings suggested that there are two interrelated contexts located in the mathematics lesson: an everyday context and a mathematical context. In the everyday context is found language used inside and outside the mathematics lesson. Mathematical language only is used in the mathematical context. Shard and Rothery suggest that there are three types of mathematical words. The first type are words which have the same meaning in both contexts, for example, ‘equal’, ‘parts’ and ‘altogether’. For the purposes of this research these are termed ‘lexical’ words. The second type are words whose meaning changes from one context or the other, for example, ‘difference’, ‘product’, ‘odd’, ‘and’. In this research such words will be termed ‘everyday’ words. The third type are words that are only used in a mathematical context, for example, ‘algebra’, ‘calculus’ and ‘polygon’. These are termed in this research ‘technical’ words. It is suggested that autistic children, as they have difficulties with language skills, focus on the subject specific technical words that have immediate meaning as they are integral to the mathematics and resources they are learning and using. Hence the language is comprehensible and these learners are therefore not confused by inappropriate mental imagery.

<table>
<thead>
<tr>
<th><strong>Brain area</strong></th>
<th><strong>Left hemisphere</strong></th>
<th><strong>Both hemispheres</strong></th>
<th><strong>Right hemisphere</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Brain processing function</strong></td>
<td>Grammatical processing</td>
<td>Semantic processing</td>
<td>External world information processing</td>
</tr>
<tr>
<td><strong>Resource</strong></td>
<td>Abstract mental imaging</td>
<td>Manufactured manipulatives</td>
<td>Real world physical objects</td>
</tr>
<tr>
<td><strong>Related language</strong></td>
<td>Technical mathematical language</td>
<td>Lexical mathematical language</td>
<td>Everyday mathematical language</td>
</tr>
<tr>
<td><strong>Bruner’s modes</strong></td>
<td>Symbolic mode</td>
<td>Iconic mode</td>
<td>Enactive mode</td>
</tr>
<tr>
<td><strong>Mode representation</strong></td>
<td>Language and symbols</td>
<td>Pictures and images</td>
<td>Physical objects</td>
</tr>
</tbody>
</table>

Table 1: Relationship between resources and language, brain function and Bruner’s modes
The discussion above can be represented as a table linking the areas of the brain responsible for mathematic comparisons and calculation with Bruner’s three modes, the developed Shuard and Rothery categorisation of mathematical language and resources. It is not proposed that the delineation presented is exclusive or fixed. However, it is suggested that such a visual representation of the relationships between the four areas might indicate both the importance of resources and where the potential for misconceptions in mathematics might lie. Table 1 clearly indicates that the area most likely to produce misconceptions in mathematics is the transitional area represented by the middle column between the real, external three-dimensional world and the abstract, internal world of thought mediated by language and its symbols. This area appears to present the greatest potential to misinterpret resource and language. It can be related to liminal space in threshold concept theory because here learners will become ‘stuck’ (see section 2.4.5). Consideration of the table also suggests that manufactured manipulative resources might be a source of confusion if the resource does not match the mental imagery or, as advocated by Dunn, Dunn and Price (1985), Smith (1998) and others, of pupils’ learning styles. The subject of learning styles will be discussed later in section 2.5.5. Before doing so, the discussion will consider recent research that indicates that use of resources is neither always needed nor helpful in supporting children’s accurate construction of mathematical patterns of thought.

2.5.3 Resources in the classroom

Classrooms contain many resources to aid the teaching and support the learning that occurs in mathematics lessons. Resources are essential to the constructivist approach to learning (Piaget, 1929, 1972) because the learner’s mental manipulation of the mathematical concept being taught will be mirrored by the physical manipulation of the resource (Bottle, 2005) during the processes of assimilation and accommodation (see section 2.4.5). In this Bottle anticipates
Wertsch (2007) who maintains that stimulus and stimuli moderate in human mental functioning. Wertsch distinguishes between such stimuli and Vygotsky’s roots in semiotics. The discussion so far suggests that both are important in enabling learning.

Example of stimuli are Cuisenaire Rods, square-sectioned wooden sticks of different lengths and colour are an example of this. They are used to explore properties of number and relationships between number, particularly number bonds of 10. The teacher in the role of mathematical ‘expert’ demonstrating through the use of such a manipulative may see the connection although Ahmed et al. (2004) showed that many teachers involved in their research did not fully understand how resources related to the mathematical concepts being taught. Even if the teacher is clear on the purpose of the resource and its appropriateness to the lesson being taught, it appears that an assumption is being made that the children will view the manipulative and make appropriate connections in the way intended (Harries and Spooner, 2000). Indeed, Cobb et al. (1992) have demonstrated that the difficulties that many of the end of lower school aged children in their research had difficulty in moving from the physical or iconic stage of mathematics to the symbolic stage and suggested that the reason lay in the choice of resources used.

As was discussed in sections 2.3.5 and 2.3.6, the meanings that children give to words may vary because of differences in background, experiences, ability, memory, orientation to the subject, other learners and the teacher. It is not unreasonable to propose that the meanings that children give to the resources given to them as the focus of a mathematical activity will also vary. Ball (1992) has pointed out that manipulation of a resource does not automatically enable learning whereas MacLellan (1997) takes the socio-cognitive view that talk stimulated by the practitioner will enable children to engage effectively with the
resource and make appropriate links with the related mathematical concept. This would accord with Vygotskian theory as Bahktin (1986) recognized, but might only be successful, and potentially only to a degree, if the language used has shared meaning. Also the practitioner has to be fully aware of the specific mathematical characteristics of the resource and the way it is intended that children’s understanding should be constructed from its use. Muijs and Reynolds (2001) have argued that resources should be as near to real-life as possible. They recognize the difficulty that children have in linking the mathematics they are learning in the classroom to their experience of the world. As Askew and Carnell (1998:24) comment: ‘all the resources for learning are already within us’. Muijs and Reynolds suggest that if the teacher cannot use a real-life example, thus validating children’s existing mathematical knowledge, an effective strategy: ‘is one that starts off with a realistic example or situation, turns this into a mathematical model leading to mathematical solutions, which are then reinterpreted as a realistic solution’ (2001:174-5).

Aubrey (1997) is cautious about this approach as her research showed that young children did not relate their classroom experiences of a resource to those in which it was used outside of this environment as the latter are often play-based and self-initiated. This is acknowledged but it can be argued that this should not prevent teachers from supporting children in making the links between real world out-of-school experiences and those created to teach specific mathematical concepts. This approach would keep mathematics in the real world from whence it came and where children will eventually practise the mathematics learnt in school. It would certainly save schools money. However, learning theory suggests that children have different learning styles to which differing resources might appeal.
2.5.4 Resources, learning styles and mental imagery

Recently there has been increasing attention focused on identifying children’s different learning preferences or styles. This is a development from various approaches that aim to identify adults’, particularly university students’ learning styles (Muijs and Reynolds, 2001). The learning style concepts associated predominantly with children’s learning are those which are based on linking teaching to a child’s natural sensory preference. It is argued that by doing so, children will learn more quickly and easily. Smith (1998), building on the Neuro Linguistic Programming work of Richard Bandler, and John and Michael Grindler, promoted in a series of publications about VAK, an acronym for visual, auditory and kinaesthetic learning. According to Smith (1998:147) twenty-nine per cent of us learn by seeing, thirty-four per cent by sound including spoken language and thirty-seven per cent of learners by engaging physically.

The argument presented so far has resulted in support for an holistic approach to language. Discussion has concluded that each child as habitus constructs individual differences in word meaning through unique sensory interaction with the real world (see section 2.3.6). S/he then brings those differences to speech events and interactions in context to enable the construction of shared meaning and communication. As seeing, hearing and touching (which involve movement) are all involved in the generation of individual interpretation of language, there is no disagreement with the identification of visual, aural and kinaesthetic aspects to learning. To place a percentage on the predominance of each in a population (unspecified) without demonstrable scientific evidence is unconvincing. Also recognition that interacting with the real world is essential for learning is not original, Piaget (1929) having advocated the need for children to manipulate objects in their pre-operational and concrete operational stages of thinking.
Adhering to a categorization of learning styles that first measures and then suggests adaptation of stock materials for the teaching of mathematics is an instrumental behaviorist approach (Jarvis et al., 1998) that runs counter to the interpretative and holistic approach suggested by this review of literature. The discussion so far indicates that enabling children to form their own mental imagery in order to create their own mental strategies to move from real world mathematical scenarios to the abstract is preferable. A crucial first stage is the understanding of numbers, the relationships between them and their properties, and the place value system (see section 2.4.3). It would appear that what is important in children learning these essential mathematical facts is not the teacher’s recognition of their predominant learning styles but the children’s knowledge and understanding of the representation of numbers in their various forms, as concrete objects, as numerical symbols, as spoken words, in a multiplicity of real world contexts as well as in schoolbooks. Unlike mastering literature, individual interpretation of object, symbol or word in mathematics is not appropriate. The language of mathematics is precise and normalised (see sections 2.3.4). Moyer (2001:176) states that the handling of mathematical materials enables: ‘learners to develop a repertoire of images that could be used in the mental manipulation of abstract concepts’. The important phrase in this reference is ‘could be used’. There is a danger that the use of manipulatives may become the focus of the lesson and not a vehicle to develop abstract mathematical thought. Children may come to depend on them and be unwilling to make the transmission to abstraction (Anghileri, 2000). Conversely, manipulatives may be taken away before children have mastered the abstraction. It is evident that the selection of appropriate mathematical manipulatives requires careful, knowledgeable consideration by the practitioner and this will involve understanding of individual children’s learning needs, not learning styles:

Observation and the resulting knowledge of the individual child is crucial to successful scaffolding. Without knowing each child well and taking the
time for careful observation and reflection before making the move to urge a child further, teachers can make serious mistakes.

(Mooney, 2000:88)

It appears from the above discussion that mental images could be the vehicle enabling transition in mathematical thinking from real world experience to abstract thought (Schoenfeld, 1987; Barnby et al., 2007). The construction of mental images arises from appropriate resources combined with language. It is proposed that, at some point, the meanings of mathematical language associated with real life experience fall away leaving only the mental image associated with the mathematical meanings of language. It is suggested that autistic children, as they have difficulties with language skills, focus on the resources and the subject specific words associated with them, and use these, and not the more general language used by teachers, to construct effective and accurate mental images.

The mental image can then be described in a new language, that of mathematical symbolism. Difficulties in mathematics are then concerned principally with the operations and logic surrounding the symbols of mathematical expression and function. As resolution of difficulties between learner and teacher will always have language as an interface, the potential for further misinterpretation of meanings is always possible. However the emphasis has changed from mathematics being language based to mathematics being symbol based. It is suggested that this is a point on the boundary of an individual’s mathematical learning that a threshold concept could be situated (see section 2.4.4).

The argument for using a variety of resources is not that these would address individual learner’s learning style but because the world out of which mathematics arises is a multi-sensory place and humans are multi-sensory creatures. Therefore mathematics resources that stimulate as many of the senses as possible reflect more closely, as Heidegger would say (Heidegger, 1962 trans.),
learners being-in-the-world. The use of sound with young children has been shown to be effective, for example number rhymes and songs linked with the showing of fingers or objects (Harries and Spooner, 2000). The traditional abacus or bead strings blocked in colour to denote five or ten engage sight, sound and touch. Bruner’s enactive and iconic modes can be engaged through the use of pictures of shapes, objects or symbols, for example, pictorial number lines, number tracks, 100 squares, digit cards and arrow cards. The number line advocated by Deheane (1998: Chapter 3) in both empty and calibrated forms enables development of greater understanding of place value and the relationships between numbers in their different guises, for example as negative numbers, decimals or fractions. Mathematical activities provided in a variety of ways that will excite the senses, particularly those of sight, sound and touch, will automatically include different types of learners. Clausen-May’s (2005) research has provided evidence that visual and kinaesthetic learners benefit from the use of emerging models and images that stimulate sight and movement.

2.6 Language, lower school mathematics and assessment

2.6.1 Introduction

The argument presented in section 2.3.3 suggested that assessment is a bridge between learner and teacher and therefore should be represented in the emerging model of learning, teaching and assessment of mathematics. The bridge of language and communication between the teacher of lower school mathematics and the learner of lower school mathematics was discussed in detail in sections 2.3 and 2.4. Section 2.4 concluded that the bridge of language in the form of dialogic inquiry (Alexander, 2004b; Mercer and Littleton, 2007) was of fundamental importance in establishing skills, generating knowledge and deepening understanding of mathematics in the early phases of education. This bridge of language combines the integrationist emphasis on the uniqueness of an individual’s total experience manifested in the language used with the pragmatic
acceptance of language. The latter arises out of shared meaning within which literal meaning is embedded, acting as a springboard for individual linguistic interactions in context. Discussion in section 2.3 identified a potential tension between this approach to language and the structuralist mechanistic biplanar code that best described subject specific mathematical language. It was proposed that difficulties experienced by learners in the lower school years might be caused at thresholds of transition between mathematics as objects in and operations on the natural world described in socio-cultural, pragmatic/integrational language and the abstract discipline of mathematics described by the structuralist subject specific language of internationally accepted and understood symbols. This suggests that assessment, which is mediated by language, might be affected by the same difficulties.

Discussion in section 2.5 established that resources were also a bridge between the teaching and learning of lower school mathematics. The conclusions from this discussion suggested that individual construction of appropriate mathematical concepts is dependent on a combination of language, resource and understanding of mathematical symbolism that is unique to the individual learner. Moreover indications were that the area most likely to produce misconceptions in lower school mathematics was the transitional area between the real, external three-dimensional world and the abstract, internal world of thought situated in the brain because of the potential to misinterpret resource and language. This area can be related to liminal space in threshold concept theory because here learners will become ‘stuck’ (see section 2.4.4). Thus the findings of the discussion on language, mathematics and resources confirmed those arising from consideration of structuralist, pragmatic and integrational linguistics applied to the learning and teaching of lower school mathematics.
Assessment is also a bridge of communication in that it enables the structured learning that occurs at school through teaching to be externalized and measured. A more formal definition is that assessment is a means of measuring and analysing ability at a particular point in time in a specified learning area or areas for a particular purpose. By ‘ability’ is meant the mental capacity to learn and to reason. Every pupil has this capacity.

In section 2.4.4 consideration of the literature suggested that mathematics is a mental construct that enables humans to tease out and understand what Stewart terms ‘nature’s secret regularities’ (Stewart 1998:15). In a similar manner to finding ways for learners to externalize the epistemological reasons why children become ‘stuck’ whilst traversing threshold concepts, teachers have to find ways for children to externalize their epistemological constructions of mathematics so that they can be assessed. There are many types of assessment and what is chosen will shape the curriculum assessed and the learning experiences of those to be assessed. The choice of assessment will be determined by its purpose, and this in turn will reflect the assumptions about the purposes of education and how children learn. For example, a transmissive and behavioural approach to the teaching of mathematics that involves rote learning of rules is likely to be assessed through written tests, whilst a constructivist and facilitative approach may be assessed by observation or the setting of a problem-solving task.

Assessment gives structure to both teaching and learning. It can take place both inside and outside the classroom and be both self and externally motivated. Assessment has different purposes. When in monitoring and evaluation mode, assessment is for learning (Assessment Reform Group, 1999). Monitoring and evaluation might take the form of informal observation or of tasks which can be oral, practical or written. Such assessments can be used as diagnostic tools to ascertain why children are ‘stuck’ and to identify misconceptions. In other words,
assessment can be used to determine whether a child has passed into a new landscape of learning where links with other aspects of mathematics already learned can be forged, or whether the child is oscillating in liminal space (see section 2.4.5). Assessment can also be of learning in summative or selective mode (Raiker, 2007). The monitoring and evaluation of learning eventually becomes summative and at some points, for example at GCSE and A level, selective. Without it, current states of skills, knowledge and understanding remain unknown or unverified, providing data neither to plan and devise future learning experiences, nor to track the progress of individual children, groups and cohorts to provide information to support whole school target-setting.

A wider role for assessment is introduced here than simply providing information for the teacher’s use to improve the learning of individual, groups or cohorts of children. It has an important role in measuring educational output enabling judgements to be made of pupils’ and schools’ performances against national standards using levels of attainment prescribed by the National Curriculum. Such assessments as the Key Stage SATs, GCSEs or even the Qualifications and Curriculum Authority’s (QCA) mid-Key Stage tests usually take place at the end of a school year or key stage. These are standardized assessments of learning, and have well-established grading and reporting procedures linked to them. The results of this summative testing inform not only teachers, but parents, members of the senior management team, governors, the local authority and Government.
In the view of various writers, including Bearne (2002) and Pollard (2006), assessment procedures which are required by Government to produce information for national league tables can cause anxiety for pupils, teachers and parents.

The following sections will consider formative and summative forms of assessment in mathematics experienced in the early years and lower school phases of education and relate them to the emerging model, threshold concept theory and, because of the fundamental importance of language in the education process, the major linguistic approaches discussed in section 2.3. As the emerging model is embedded within a physical and socio-cultural matrix, the discussion will begin with an appraisal of current policy on assessment.

2.6.2 Current policy

In recent years, since the advent of The National Curriculum in 1988, assessment in schools has been dominated by measurement and summative assessment (Hargreaves, 2005). Assessment, monitored by Ofsted and HMI, has become increasing important in education as a means of standardization to achieve national improvements in children’s achievement. The early years and lower school phases are prescribed by The Curriculum Guidance for the Foundation Stage (CGFS; DfES, 2000), The National Curriculum for Key Stages 1 and 2, (1999a) and The Primary Framework (2006a). The latter document has sections for both English and mathematics for Reception. The CGFS has attainment targets in the form of ‘stepping stones’. All children are assessed summatively at least once in the early years to provide a benchmark from which to measure progress in various areas, including mathematics. The primary school phase is assessed summatively against the attainment level description that form part of The National Curriculum document. Children are assessed for national statistical
purposes at the end of Key Stages 1 and 2, that is, at seven and eleven years of age. There are national summative non-statutory tests available for the intervening years.

The Government’s (DfES, 2003a) aim was that at least eighty-five per cent of eleven year olds to achieve Level 4 in literacy and numeracy, and to improve rates of achievement at Level 5 by 2006. The eighty-five per cent target for Level 4 was chosen as the result of research into the 2001 Key Stage 1 results and the effect of differing rates of progress on Key Stage 2 SAT results. It was found that nearly seventy per cent of pupils achieving Level 4 or above in English or mathematics at Key Stage 2 in 2001 progressed to attain five grades in the A*-C range at GCSE in 2003, whereas only eleven per cent of those who did not reach Level 4 did so. The DCSF announced that the 2007 Key Stage 2 SATs results demonstrated record achievements in English, mathematics and science, the results showing a one percent increase in all three subjects to eighty per cent, seventy-seven per cent and eighty-eight per cent respectively (DfES, 2007a online). Among other statistics released by the DCSF were that the number of children achieving Level 4 in both English and mathematics had increased by one percent from 2006 to seventy-one per cent in 2007, and that children’s achievement across the ‘3 Rs’ of reading, writing and mathematics remained the same at sixty per cent.

As the targets have not been met for English and mathematics, the DCSF introduced further measures in September 2007 (DfES, 2007b online). These included greater emphasis on mental mathematics with tables to be learnt a year earlier than specified in The Primary Framework (DfES, 2006a), and the development of a similar intensive daily scheme to the Every Child a Reader programme for six-year olds having difficulty with mathematics. Also launched in September 2007 was the Making Good Progress pilot with 484 schools taking
part. Lower school aged children who were having difficulties with English and mathematics would be given one-to-one support that would prevent children ‘getting stuck’ in liminal space (see section 2.4.5), unable to traverse the threshold. Included in the package were new means of assessment though at the time of writing these have not been made public. It has been suggested in section 2.4.4 that up to certain points, and these will differ with individual children and the specific area of mathematics, all concepts are core concepts because fundamental mental networks of skills, knowledge and understanding in number, calculation, measurement, data-handling and shape and space are being established. However at some point these fundamental but separate mental networks are linked as threshold concepts are mastered. After this point there will be ‘core concepts’, the threshold concepts, and other non-core concepts of lesser importance to the progress of mathematical understanding. It will be interesting to see whether a differentiation of concepts in such terms can be identified from the outcomes from the assessments associated with the Making Good Progress pilot.

So the focus for changes in assessment is being placed firmly in schools. It does not appear that the Key Stage 2 SATs format will alter. As was intimated above, assessment drives the curriculum. It will be teachers and schools that will be effecting the changes to increase achievement in Government tests. The introduction of the Government’s principal method for encouraging enhancement of teaching and achievement, The Primary Framework (DfES, 2006a), was accompanied by teachers receiving teaching materials, lesson plans, advice and training days but not sessions on improving subject knowledge and pedagogy. It appears that the mechanistic, instrumental behaviourist approach to mathematics teaching and learning discussed in section 2.4.2 is destined to continue. The Primary Framework (2006a) for both English and mathematics emphasises the two forms of assessment discussed above, of learning being summative assessment and for learning being formative assessment. These will be
discussed in detail in section 2.6.3 with reference to the linguistic approaches discussed in section 2.3. The Primary Framework sees assessment as an essential tool for enabling teachers to plan in order to identify: ‘what children can do and what they need to do next’ (ibid.:10). The associated electronic Primary Framework has been constructed to give guidance on assessment both during and across a sequence of lessons. This confirms the view expressed above that improvements in children’s learning are regarded as being the responsibility of the teachers and not with the Government’s selection of curriculum content, attainment descriptions or testing methods. However, The Primary Framework recommends that assessment should take the form of: ‘informed observation and effective questioning’ (ibid.). These are qualitative methods and suggest pupil-centred learning, a more constructivist approach. However, as has already been argued in section 2.4.2, the aim of such an approach is to standardise learning and therefore could be regarded as a more subtle form of instrumental behaviourism (Jarvis et al., 1998).

As well as forming part of a planning cycle based on children’s individual needs in mathematics, assessment also has a socio-cultural dimension in that it contributes to a cycle of accountability driven by the Government’s agenda. This cycle begins with monitoring, whereby children’s progress in mathematics is evaluated on a daily and weekly basis. These assessments are recorded, informally as teachers’ jottings on plans or more formally if the recordings are needed for a wider audience. At some point teachers will be required to report on the recorded and evaluated assessments to a subject coordinator, senior management team, parents or governors. Finally the reports contribute to information used to produce league tables of schools and to inform the Self Evaluation Form (SEF) which gives direction to inspections by Ofsted and HMI. It is clear how summative assessments of children’s work fits in to such a process as such assessments take the forms of written tests and are thus assessments of
learning. It is less straightforward to determine the role of formative assessment or, as it is now termed, assessment for learning (AFL) in the instrumental behaviourist structure of the National Curriculum, Primary Framework and related documentation.

2.6.3 Assessment for learning

AFL resulted from the work of the Assessment Reform Group (1999) and Black and William (2003). Their influential research demonstrated that the summative assessment not only fails to enhance learning but may actively contribute to hampering it. That the presentation of summative assessment can hamper learning was confirmed by a preliminary investigation for this thesis carried out by the author as an analysis of errors in a Key Stage 1 national mathematics assessment. This preliminary investigation followed from that into possible relationships between competencies of lower school children in language and mathematics in Bedfordshire described in section 2.4.5. Two thousand datasets from the Performance Indicators in Lower Schools (PIPS) Year 2 mathematics test were analysed (Appendix C). The first finding was the substantial amount of knowledge of different formats of questions and how they were to be answered had to be mastered by children before the actual mathematics of the questions could be accessed. Questions were presented in thirteen different forms under symbolic, representational, syntactic and lexical subheads. The thirty-eight questions, or assessment units, in the PIPS mathematics assessment were then analysed for differences and similarities in presentation. These differences and similarities were called elements because they were perceived to be the basic building blocks of which the assessment units were constructed. The elements were categorised and defined. Their variety demonstrates the considerable recognition skills children have to master in order to respond correctly to the mathematical content of the assessment units.
The questions were then analysed to determine if they fell into question types (Table 2 below). Seven distinct types were identified although eleven out of the thirty-eight questions could not be assigned to these, thus underlining the multiplicity of forms having to be mastered by children before the mathematics could be accessed. It was found that the fewest errors were made in answering questions composed of mathematical symbols only (Types 2 and 3).

<table>
<thead>
<tr>
<th>Type</th>
<th>Description and example</th>
<th>Assessment Unit</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Posed in words and numbers written as symbols. What is 10 shared between 2?</td>
<td>2, 11, 12, 13, 20, 21, 22, 24, 27, 29, 31</td>
</tr>
<tr>
<td>2</td>
<td>Posed in numerical and operational symbols. $4 + 11 =$</td>
<td>3, 5, 6, 7, 23</td>
</tr>
<tr>
<td>3</td>
<td>Involved inserting a number in place of a star. $3 + * = 9$</td>
<td>8, 9, 15</td>
</tr>
<tr>
<td>4</td>
<td>Adding up money. Coins were drawn and the value written underneath in the form, for example, 5p</td>
<td>14, 19</td>
</tr>
<tr>
<td>5</td>
<td>Interpreting a bar chart. How many cars did Ruth count altogether?</td>
<td>16, 17, 18</td>
</tr>
<tr>
<td>6</td>
<td>Identifying or counting mathematical shapes. Which shape is the pentagon?</td>
<td>28, 34</td>
</tr>
<tr>
<td>7</td>
<td>Interpreting a table. How much does the most expensive pizza cost?</td>
<td>35, 36, 37, 38</td>
</tr>
<tr>
<td>8</td>
<td>Could not be placed with any other assessment unit to make distinct type.</td>
<td>1, 4, 10, 25, 26, 30, 32, 33</td>
</tr>
</tbody>
</table>

Table 2: Presentation types identified in PIPS mathematics assessment

The findings suggested that the rubric of English and/or the graphic presentation of the questions were causing problems in this written mathematics test. The marking and feedback strategies mode of AFL uses the written word (Black and William, 2003; Raiker, 2007). However AFL uses predominantly verbal language in the remaining three modes of sharing learning goals, using effective questioning techniques, and peer and self-assessment (ibid). Discussion in section 2.4.4 suggested that verbal language might be a cause of problems in children learning and teachers teaching mathematics. This will now be considered in relation to the assessment of mathematics.

AFL is: ‘the process of seeing interpreting evidence for use by learners and their teachers to decide where the learners are in their learning, where they need to go
and how best to get there’ (Assessment Reform Group, 1999:3). This could be a definition of threshold concepts (see section 2.4.4). In the classroom, formative assessment of individual pupils is made to ascertain the degree to which learning objectives have been met. Future teaching can then be tailored to the learning needs of each pupil. In the past this kind of assessment was undertaken solely by teaching professionals. However, discussion in sections 2.3 and 2.4 has demonstrated that pupils are not empty vessels into which teachers pour knowledge and understanding. Aubrey (1997), in summarising her research into the co-ordination and utilisation of teacher and pupil mathematical knowledge in Reception classrooms, notes that none of the four teachers interviewed and observed made use of his/her children’s pre-school experience. She observes that this experience was recounted in the spoken language and describes it as being rich and varied, enabling nearly all the children in her sample to attain National Curriculum attainment targets in data handling before school entry. This resonates with an integrational linguistic approach. Each individual has to construct his/her own view of the world based on reasons that have meaning for him/her. This cognitive view of how pupils learn means recognition has to be given to pupils who have an understanding of what they do and do not know. So they too must be brought into the assessment process so that teaching activities can be modified to stimulate them towards fulfilling their potential. The teaching professional and the pupil can both give feedback on the assessment with the teacher taking the lead as the ‘expert’ on what is needed to meet the learning objective (Piaget, 1972). It is the pupil’s task to achieve the learning objective. Research by the Assessment Reform Group (2003) and Clarke and McCallum (2003) have demonstrated that this approach can increase pupils’ learning.

AfL appears to have two distinct aims, the first to enable children to learn according to their personal constructs and for their own purposes, and the second to enable them to meet the Government’s agenda as expressed in the
documentation mentioned above, the 'incidental and intentional modes of
education' according to Dewey (cited in Murphy, 1999:23). So assessment not
only fulfils the teachers’ need to inform effective teaching in order to enable
learning for all pupils; it also provides feedback to the children to motivate them
and provide them with foci for their work. Cowie (2005) maintains that the aim of
AfL is to enhance learning, not measure it, thereby being in opposition to the
ethos of national testing. It must be remembered that the criteria against which
children monitor their work will have been taken by their teachers from *The
Primary Framework* which is directly related to SATs and QCA tests (see section
2.4.2). Achievement using AfL is therefore ultimately measurable. However
Cowie (2005) proceeds to explore issues of inclusion and equal opportunities in
that she discusses how barriers to success in assessment can be broken, an
issue at the heart of the ECM (2004a) agenda. Thus it can be said that formative
assessment aims to maintain a balance between the individual child and society
and their respective needs, whereas summative assessment is principally a
socio-cultural imperative. However Broadfoot and Black (2004) maintain that the
attempt to cope with the demands of Headteachers and regulatory authorities to
embed assessment for learning in practice has caused teachers anxiety and
frustration.

AfL involves the use of predominantly verbal language and social interaction with
learners playing an active part in constructing their own understanding. This
reflects the fundamentals of socio-cognitivist theory. Vygotsky (1986 trans.) in
particular stressed the importance of language and the socio-cultural context in
learning. More recent researchers and writers (Bruner, 1996; Freire and Macedo
in Leach and Moon, 1999; Lee and Smagorinsky, 2000; Loughran, 2006;
Wertsch, 2007) have confirmed Vygotsky’s perceptions that knowledge is socially
constructed through orientated, proactive collaboration. All give a high priority to
language and dialogue in the process of intellectual development although Freire
(cited in Leach and Moon, 1999:53) warns that: ‘Critical educators should avoid at all costs the blind embracing of approaches that play lip service to democracy and should always be open to multiple and variable approaches that will enhance the possibility for epistemological curiosity with object of knowledge’.

This reflects the finding of the Earl et al. (2003) evaluation of the first years of The National Literacy and Numeracy Strategies that teachers adopted the behaviours involved in fundamental pedagogical change but did not understand the underlying principles (see section 2.4.2). It suggests that lack of enhancement of teachers’ skills, understanding and knowledge of mathematics during the introductory training for The Primary Framework might be counter-productive. Socio-cognitivism has profound implications for classroom practice as there must always be opportunities for children and practitioners (teachers, teaching assistances and other knowledgeable others) to engage in discourse, particularly that which will result in assessment for learning. This suggests that lesson organization should encourage collaborative work, for example for the children to work in pairs or small groups (Pritchard, 2005:32). However there are issues surrounding a socio-cognitive approach to assessment in mathematics. The National Curriculum and The Primary Framework present the progression of mathematics in what can be described as a traditional framework of Piagetian developmental psychology, dependent on increasingly potent forms of logical deduction. Liminal space and Vygotsky’s Zone of Proximal Development do not appear to exist in this scenario. Such an approach accords with the emerging model as presented in section 2.3.3 with a structuralist linguistic approach to language and the teacher/curriculum at the centre.

To recap, the structuralist approach to language links words and their meaning through a mechanistic code-like system where the word has autonomous defined meanings that are related neither to the individuals uttering them nor to context of
the place and event. Assessment is a simple matter of assessing what is right and what is not with errors purely the responsibility of the learner. However there is inconsistency in Piaget’s approach (1972) as he maintained that the learner would only learn when s/he was ready to learn and the teacher simply created the learning environment. In this scenario the learner should be at the centre of the structure, and not the teacher/curriculum. Taking Piaget’s constructivist approach into the social domain where children are encouraged to express their mathematical ideas and to explain their own methods of investigation or verification represents a more dynamic relationship between teacher and learner and also between learner and learner. The modes of questioning techniques, and peer and self-assessment used in AfL are now relevant. As socio-cognitive interactions take place outside the school as well as within it, such an approach accepts that the learner will develop mathematical concepts from sources beyond the classroom walls.

As it has been proposed in section 2.7.1 that the learner cannot learn without assessment, this suggests that learners are engaged in self-assessments based on learnt and tacit knowledge (see 2.4.5). The results of such self-assessments might present possible contradictions to the learner resulting in fragmented knowledge and entry into liminal space (Meyer and Land, 2006). There are similarities here to those discussed in considering the implications of the use of resources by autistic children (see section 2.5.1) and with children’s learning of science (Milburn 1972; Happs, 1983; Dove, 1996). The linguistic approach that reflects socio-cognitivism is pragmatics. Pragmatics provides opportunities for inaccurate assessment both by self and others because it is assumed that participants have had an adequate number of similar mathematical experiences and understandings of non-linguistic knowledge arising from a shared socio-cultural background. It was argued in section 2.3.4 that vital information can be
left out of accounts because assumptions have been made on the scope of those shared experiences and non-linguistic knowledge.

Both spoken and written words are used in assessment for learning modes of questioning techniques, and peer and self-assessment. It is argued that a pragmatic approach to assessment in mathematics might result in unreliable data because both pupils and teacher bring their own meanings of words embedded in their own individual experiences into the assessment exchange. Furthermore, the contexts in which the questions are embedded can cause difficulties. It appears that liminal space and Vygotsky’s ZPD have a place in this scenario, as argued in section 2.4.7. Donaldson’s (1978) and Blinko’s (2004) work seems to suggest that pupils prefer questions embedded in a context and that this enables them to achieve at a higher developmental level as defined by Piaget. However, as demonstrated by Cooper and Dunn (2000), mathematics questions set in contexts that contained unfamiliar language, graphics or events with specific conventions and practices could prevent children from accessing the mathematics being tested and propel them into liminal space. As was proposed in section 2.3.5 when discussing the implications of the pragmatic approach on the emerging model, the teacher moves closer to the learner and away from the mathematics curriculum. However, unless the teacher uses the correct language set in appropriate context, the greater empathy with the learner will neither necessarily result in accurate assessment of learning nor in a lessening of liminal space. There is also the potential for the teacher to become so close to the learner that learning becomes more individual than Government driven. Here the learning environment is veering towards Toolan’s (1996) integrational perspective where there is no literal meaning on which to base assessment on shared understanding. Taking this to its extreme position, the implications of integrational linguistics for the bridge of assessment in the emerging model would be that the external socio-economic context, that is Government-driven assessment, would
cease to exist as a discernible entity as assessment becomes totally
dividualised as at Summerhill (Summerhill School, 2004 online). The bridge of
assessment would still link the learner and teacher but with the learner/curriculum
at the centre of the emerging model and the teacher encircling as the external
helix. Assessment as a normalizing, standardizing process would cease to exist.
However the total space between learner/curriculum can be regarded as liminal
space and a ZPD in its purest form.

Another important consideration of AfL in mathematics is that mathematics
involves an increasing understanding of its abstraction. To recap, children have
to transcend the exploration of particular instances of the natural world using
socio-cultural language to attain the generalised abstractions of mathematics
expressed in its specific symbolism. My Master’s research (Raiker, 2000)
demonstrated that, apart from numbers, the children in the study rarely used the
subject specific mathematical language pertinent to the learning objective, yet
this was the language used in mental and written tests. It appeared that the
potential for mathematical abstraction might be hindered by the linguistic
variability provided by talk because children do not have sufficient practice of
using and embedding in their cognitive structures the subject specific language
carrying key mathematical ideas. In contrast, Bruner (1964) upholds the
importance of the concept of reciprocal learning. He maintains that even when an
individual is talking, s/he will be receiving ideas and feedback from others in the
group that will lead to a rethinking of ideas whilst in the process of speech. In this
he is following Vygotsky’s (1986 trans.) perception of internal regulation that
maintains that difficulties in finding the ‘right’ words to describe an event may lead
to modification of the analysis of that event.

Bruner develops this perception by arguing that it is the immediacy of response,
which may be verbal or non-verbal, that enables shifts in cognition to take place.
As Hoyles (1992) observes, reflecting Foucault (1980), the natural conflict of ideas that arises in discussion enables a learner to decentralize through thinking about another’s perception of a mathematical idea or problem and this may stimulate progression. Bernstein’s (1965) work supports this view in that he believes that such conflict would stimulate a learner to move from context-specific arguments with undefined terms and built in assumptions to explicit formulations. It is possible that argument and discussion within a mathematics lesson could help children shift into a disembedded use of language that transforms into an abstract appreciation of mathematics. It therefore follows that argument and discussion during an assessment would allow a child to demonstrate not just the current state of her/his mathematical knowledge but understanding of language and potential for development.

If one subscribes to the view that children are not simply silos for the storage of adult knowledge but are actively and constantly trying to make sense of all that surrounds them, then total adoption of the hierarchical view of mathematics teaching and assessment has to be questioned. Research by Denvir and Brown (1986) has shown that assessment of children’s current state of mathematical knowledge does not give an accurate indication of what they would learn next. Instead assessments suggested a range of concepts each child might gain next. This reflects concept threshold theory in that knowledge is bounded with a multiplicity of exit points that can be the sites of threshold to the next stage of learning. Although Denvir and Brown were careful to limit their findings to the research site of a small number of London primary schools following similar curricula, they were confident in concluding that assessment of children’s understanding of concepts is more valid if based on their use of strategies than on the total number of questions answered correctly in a written test.
How the child tackles the problem is frequently more a function of the context, mode of representation, and individual interpretation than of the child’s cognitive or intellectual ability.

(Denvir and Brown, 1986:32)

2.7 The Learner/Teacher Dynamic

The literature review has provided a process relationship between mind and socio-cultural setting as defined by Vygotsky and expanded through Wertsch through his perception of mediated action. Within this framework Bruner’s (1960) model of the spiral curriculum has provided a fundamental image for the construction of the model proposed in this thesis. He argues that, over time, any curriculum should regularly revisit taught topics whilst the knowledge of a subject is expanded. Knowledge is thereby reinforced and embedded in the widening context. In terms coined by Piaget (1929) this means that there is a constant dynamic in an individual’s construction of concepts between them being accommodated as a result of new concepts being accessed and assimilated by learners. He believes that the teacher had a part to play in guiding and accelerating learning, unlike Piaget who believes that the teacher’s contribution to enhancing learning readiness is minimal (1972).

Socio-cultural studies of the function of the mind derived from the work of Vygotsky and Bakhtin have explored the way in which historicity plays a significant part in human action and interaction. Reflecting this, Bruner’s spiral curriculum with its temporal and spatial dimensions is regarded as particularly significant for this thesis as mathematics builds on earlier concepts in a hierarchical structure. However, a spiral is a two-dimensional shape. It does not take into account the fact that the learner is assimilating and accommodating learning all the time whilst accessing the curriculum at an increasingly higher attainment level. In order to address the dimension of revisiting learning over time and the subsuming of earlier mathematical concepts within the learner to form springboards to those at higher levels, the emerging model will take the form of a
helix. It is acknowledged that also subsumed within the learner are personal, social and emotional factors and motivation issues. However these factors will not be investigated in this research that is focusing on the role of language in the learning, teaching and assessment of mathematics.

Bruner put the learner at the centre of his theories. This approach has been confirmed by Government in their publications ECM (DfES, 2004) against the principles of which Ofsted inspect schools, ‘Excellence and Enjoyment (DfES, 2003a) and the Children’s Act (DfES, 2004c). Excellence and Enjoyment (2003a:39) states that: ‘Learning must be focused on individual pupils’ needs and abilities’. It has been suggested that the mathematics curriculum can be visualised as a helix. Therefore it is proposed that the learner is placed within the helix as is represented below.

Figure 3: the Learner/Teacher Dynamic
The teacher will have her/his own teaching style, motivations and abilities in particular areas but it has been argued that it is Government imperatives culminating in assessment against national standards that drives the mathematics curriculum. Therefore the model proposes that the teacher and curriculum be regarded as an intertwining double helix with the learner at its centre.

The model does not exist in a vacuum but in a classroom, a space specifically created for teaching and learning. Previous discussion has established the Governmental statutory and non-statutory requirements for what children should know in mathematics and how that knowledge should be measured. Thus the structures and processes of Government are dictating the structures and practices of the classroom. Such practices arising over time and out of the cultural requirements that produced them, are structured by them, and structure current action and thought. A culture perpetuates itself by transmitting its distinctiveness (Bourdieu, 1989). and does so through the fusion, the inseparability of the individual and the socio-cultural As Lantoff observes:

\[ \text{(Lantoff, 2004:30-31)} \]

The classroom is a space created to transmit socio cultural practices in perpetuity and to develop thinking. For these reasons the Learner/Teacher Dynamic is placed within the matrix of the physical and socio-cultural environment of the classroom.
3 Methodology

3.1 Introduction

The discussion so far has clearly distanced this research from a positivist, empirical position. Conclusions generated from consideration of philosophical texts have made untenable the view that, for the sake of neutrality and the maintenance of objectivity, the researcher has to be nothing but a passive tool of data collection. The ontological and epistemological argument developed through study of the literature locates the knower (the researcher) in the construction of the known (the constantly changing interaction between society and its constituent individuals). Thus data are produced not collected. It is the method of production that is essentially related to the product, in this research the realities revealed by analysis of the data so produced. However in taking such a position, this research does not maintain that is not open to scientific scrutiny and rigour. A difference is perceived between a scientific approach that sees science as the only form of legitimate knowledge, and a scientific approach that is defined in terms of method based on observation and deductive reasoning. This research demonstrates significance, theory-practice compatibility, generalisation, reproduction, precision, rigor and verification. These are all elements of what can be termed ‘good’ science. However, in taking this qualitative approach there is a danger that the research could be criticised for false necessity, a term coined by Robert Ungar (1987). This is interpreted as follows. Subjecting research to the elements of ‘good’ science detailed above is not sufficient. Implicit in the necessity of the reliability of research is a sense of consensus in its conclusions and recommendations.
3.2 Statement of self

The purpose of research is to question and investigate the assumptions which, at
the point of research, justify the perception of some aspect of reality. As the
question and methods of investigation are all produced through the researcher
she too must be questioned and her assumptions revealed. A statement of self
appropriate to the ontological and epistemological approach from which the
literature was reviewed was given in section 2.2. This statement will now be
expanded to embrace the paradigm and methodology underpinning the collection
and analysis of data. It will be noted that ontological, epistemological and
methodological consistency is maintained in that the same stance based on the
perspectives of Bourdieu and Heidegger and a holistic approach to language and
its role in the learning, teaching and assessment of mathematics in the early
phases is adopted throughout Chapters 3 and 4. The researcher is aware of her
own subjectivity in the creation and carrying out of this study. She also has some
awareness of the emotions and unconscious processes that underpin her being a
researcher and have brought her into the lives of those that are the subjects of
this research (see section 2.2). Walkerdine (1985, 1997) categorises the
research process in terms of surveillance, truth, fictions and fantasies. This is
interpreted by the researcher in terms of Bourdieu and Heidegger in that dasein
will bring her habitus of roles, experiences and the resulting emotions into
different fields (see section 2.3.4). One can think of dasein as being a character
in her own fiction, an interpretation of past events. Heidegger’s sense of time
(1962 trans.; Macann, 1993) dictates that this fiction is also the present and the
future, the eventuality of which lies in the present that is the result of the past. For
Walkerdine, the future is a fantasy played out eventually in the present forming
the fiction that can be recounted. The researcher approaches the observation,
the surveillance of phenomena, in the search of truth. However the researcher
and those researched are both ‘subjects’. So the research encounter demands,
as Walkerdine et al. (2002:180) succinctly state:
...a complex understanding both of the discursive constitution and the ways in which the relations between positionings are held together by and for the subject in ways which can be quite contradictory and conflictual. This works both for the researcher ... and for the research subject and indeed for the dance between them which produces the stories told within the research. Understanding subjectivity therefore demands an understanding of emotions.

The defences are detachment and concentration on the role of the moment, in this case of researcher and researched. It is immediately obvious how important it is to maintain the usual routines and ambiance of classroom activity. With this outcome in mind, the researcher made every effort to plan the research down to the last detail to minimise intrusiveness and keep relationships with the researched on a professional level. However, it had to be recognised that the partnership in this dance was weighted. The researcher comes with authority by virtue of being a researcher and a member of a University. As well as incorporating a sense of social hierarchies, values and status, authority contains the sub-word author. The researcher did indeed create the story of what happened in the classroom and what was to be disseminated. It will be seen as this chapter unfolds that the researcher approached the collecting of empirical data with responsibility, created appropriate ethical protocols and provided reciprocal services within the research school. Even so, the researcher had to be very aware of the possibility of creating the identities of the researched and the nature of their activities for her own ends (Skeggs, 2001). She must acknowledge that her role of researcher in the school differs from that of governor. As governor she observed the processes and procedures of learning, teaching and assessment from the viewpoint of a long term 'critical friend' with shared responsibility for outcomes measured against national norms. As a researcher she observed the same processes and procedures with academic detachment, having responsibility for the validity and reliability of her research. Her responsibilities towards teachers, teaching assistants and children were ethical. As a researcher her relationships with teachers, teaching assistants and children
were short term, created for the purpose of the research to withdraw from them once the data has been produced. Her role as governor, her *habitus* and the investment of her time in this research could affect the course of data production and analysis. The field notes undertaken as a methodology were essential for the researcher to externalise emotions and identify possible areas of conflict between the roles of governor and researcher, confront them and minimise their impact on the research process (Appendix D). Through them, the researcher moved from what May (2000) terms as endogenous reflexivity, that is a sense of self arising from all past experiences and influences, to that of referential reflexivity where the researcher restructures her sense of self through assimilation and accommodation of the reflexivities of others. This sits well with Heidegger’s definition of *dasein* as a verb, ‘being’, changing with the flow of time in response to thought and interaction with things and people.

3.3 Choice of research sample

The research sample was chosen from the 134 Bedfordshire lower schools surveyed in the preliminary investigation for this study. School X is a small village school of situated in North Bedfordshire. It was chosen as the research sample and site for the following reasons:

- The data to be collected by the methods discussed below would be very rich. Therefore the research sample would have to be limited to prevent overload of data for the size of study;
- The sample chosen for data collection and analysis had to be sufficiently large for the results to be meaningful in terms of the research questions;
- The sample had to provide a breadth of data to be set against local and national contextual data;
- The research site had also to be sufficiently contained for the holistic philosophy and paradigm on which the research is based to be addressed;
- Most pupils were of white UK heritage. A small number were from other white or dual heritage families but all spoke English. This eliminated a potential significant variable in the consideration of language’s role in subject teaching;
- The Ofsted reports of 10 February 2003 and 5 January 2008, occurring either side of the data collection period, both recorded that pupils came...
from a range of social backgrounds that are broadly average and that the proportion of children entitled to free school meals and that with learning difficulties and/or disabilities are similar to the national average. Thus the school is representative of national trends;
- The Acting Headteacher and governors supported the research and gave permission for it to be carried out in their school.

The current research was built upon the findings of my Master’s dissertation (see Chapter 1). This earlier research took as its site six classes from five Bedfordshire lower schools of differing controlling interest, size and location in order to determine the use spoken language in mathematics lessons, and how meaning and understanding are achieved. These classes spanned years 2, 3 and 4 and included two village schools. The preliminary investigation on the relationship between SATs results in literacy and numeracy outlined in section 2.4.6 also focused on Bedfordshire lower schools of which thirty-five per cent are village schools. It was therefore appropriate that the research site of the current research should be a village school within Bedfordshire.

The site for the current research was a Bedfordshire village lower school with forty-two children between the ages of four and nine years on roll. The school was just emerging from a period of considerable instability when the research took place. A substantive Headteacher was appointed to start in January 2007 following a period in excess of three years when leadership had been carried out by a series of Acting Headteachers including two periods of federation with local schools. Staffing at the school had been through a high level of change with some redundancies and other staff movement in and out of school during the three year period. Results over the past five years have been mainly below national levels. The year 2006-07 was deemed by the School Improvement Partner as the most stable for the school regarding staffing (Summer School Improvement Partner Visit Report, 2007).
Observations recorded by video and audio equipment, interview and the study of documentation took place during the academic year 2006-07. Two mathematics lessons were recorded in each of the school’s three classes, one in November 2006 and one in March 2007. During the course of the research Class 1, the Reception class teacher worked with eight children, the Key Stage 1 teacher in Class 2 with sixteen children and the Class 3 teacher with eighteen children. In addition the Acting Headteacher took classes to release teachers for planning, preparation and assessment time. Teachers in Classes 1 and 3 were supported by a teaching assistant during the November 2006 recordings, and in Classes 1 and 2 during the March 2007 recordings.

The children came from a range of socio-economic backgrounds with twenty-five per cent of the children coming from hard pressed families, eighteen per cent from families of moderate means, forty-eight per cent of families that were comfortably off and nine per cent that were wealthy achievers (Bedfordshire County Council, 2006). The ethnic backgrounds of the learners was predominantly white British (seventy-two point five per cent) with four children from British mixed white and black Caribbean families, one from a British white and black African family, one from a British Bangladeshi family, two children from South African families and one child each from Italian and Polish families (School Self Evaluation Form, 2006: Appendix E).

3.4 Choice of paradigm and methodologies

3.4.1 Institutional ethnography

This research is centred on language and its role in a particular area of the lower school curriculum, mathematics. That there is such an area suggests structure and there is a structure, the institutional structure of education. As has been discussed in previous chapters, throughout English schools English and mathematics are taught according to The National Curriculum, Numeracy and
Literacy Strategies. These are national documents produced by the DfES on behalf of Government. This being so a study of the role of language in mathematics would be served by the approach of institutional ethnography. In her justification for the recognition of institutional ethnography Smith (1987:60) defines an institution as:

…a complex of relations forming part of the ruling [relations], organised around a distinctive function-education, health care, laws, and so on… Characteristically state agencies [and laws] are tied in with professional forms of organisation, and both are interpenetrated by relations of discourse of more than one order.

Ethnography is attractive for this researcher because it is focused on researching and writing about individuals and their relations in their everyday world of working (Benson and Hughes, 1983, Bogden and Biklen, 1992; Hammersley and Atkinson, 1994). The study of dialogue in both spoken and written forms is placed at the centre of the research. Gee and Green (1998:126) describe as an ethnographic perspective an approach to discourse analysis that:'…forms a basis for identifying what members of a social group (e.g. a classroom or other educational setting) need to know, produce, predict, interpret, and evaluate in a given setting or social group to participate appropriately and, through that participation, learn (i.e. acquire and construct the cultural knowledge of that group'. Institutional ethnography is also attractive for this researcher as her ontological and epistemological stances perceive the structured and structuring necessities of social relations yet recognises an external reality that is comprehended through sense-experience, is extended by science and is understood through individual construction and communicated by language (Gee and Green, 1998). Despite adhering to many of Heidegger’s perceptions on the nature of being, the researcher has found him wanting on explanations of the emergence of structures underpinning the integrated pattern of knowledge, beliefs, ideas and artefacts that necessitate the learning and transmission of that
knowledge to following generations. This means that a phenomenological ethnographic perspective as developed by Schultz (1967) from original work by Durkheim and Weber, whereby the effect of social impact is nullified by emphasis on the subjective, is not appropriate for this study.

At the heart of institutional ethnography is the understanding that, for researchers to describe accurately and interpret with some authenticity in a given field, to use a term of Bourdieu, they have to understand the researched and have their trust. To do this, it is helpful if the researcher and the researched have sufficient and similar experiences of that field to engender that trust. This research wishes to avoid the criticisms, directed at European ethnographers constructing accounts on and explanations of behaviours of peoples outside the western hemisphere, that their interpretations reflect their own places and times and are lacking in objectivity (Said, 1978; Crapanzano, 1986; Clifford, 1986). The author’s experience of twelve years in lower school classrooms, seven years as a governor, and three years as a link tutor with the research school is considered to be sufficient and similar experience. However the strength of the researcher having such similar and sufficient experience to the researched opens the researcher to criticisms of subjectivity. Additionally, an argument could be levied that the results of such research are particular to the research site and are not generalisable as should be the case if the findings are to be reflective of ‘good’ science.

In response, the researcher would argue that the statutory and non-statutory structures provided by the institution of education and adopted by Bedfordshire schools in accordance with Local Authority guidelines, together with measures undertaken to maximize reliability and the researcher’s reflexive approach,
establish an acceptable degree of objectivity. The researcher maintains that sufficient and similar experience is necessary for her to locate ‘...a standpoint in an institutional order that provides the guiding perspective from which it will be explored’ (Smith cited in May, 2002:43). Moreover, because the research school is an institution within an institution, that of education, the results will be generalizable to that wider institution within limitations. However it must be remembered that this research is aimed at producing rich data that will provide insights into the role of language in mathematics at the case study school. As will be discussed in section 3.6.2 the methodology created for this research will provide generalisability. In conjunction with the Learner/Teacher Dynamic, a method of approaching the study of the role of language in mathematics within the institution of education has been created as an element in this researcher’s contribution to the body of knowledge. It is recognized that the structuring structure (Bourdieu, 1990 trans.) that is the school, its teachers and pupils is a complex environment, subject to the contradictions inherent in individuals and the processes and procedures created through their social interactions. Any attempt to understand how individual children learn and individual teachers teach mathematics is not going to be straightforward and unproblematic. Thus underlying the paradigm chosen for this research is the necessity of finding that standpoint, that acceptable point of balance between observation and interpretation, the individual and the social, and the subjective and the objective, the reflexive and the reflective. The purpose of this research is to reveal through a scientific approach based on observation and deductive reasoning that does not depend on quantification, the role of language in the learning, teaching and assessment of mathematics. Science and mathematics both involve numerical formulation and operation but the data produced for analysis will be in the form of
discourse and elements of non-verbal communication. As Bhaskar (1989:46) writes of the limitations of quantitative analysis in the social sciences:

Language here stands to the conceptual aspect of social science as geometry stands to physics. And precision of meaning now assumes the place of accuracy in measurement as the a posteriori arbiter of theory.

However, whilst bearing this in mind, because of the outcome of the literature review that structural/semantic, pragmatic and integrational linguistics support and are not in opposition, quantitative analysis will be included in this research under the umbrella of an institutional ethnographic perspective (see section 3.4.4 below).

Discourse is seen a social semiotic, a structuring structure. Smith (1999:43) defines discourse as a tool ‘...to designate a class of those relations that organize the local translocally’. Clearly within this definition is a sense of the structuring power of discourse as it organizes the social relations between individuals. It also suggests that locality is key to the understanding of discourse and the roles and power structures inherent within it (see section 2.3.7). The locality of this research is a school and the discourse that will be investigated will be that related to the numeracy lessons taking place within it. A school is a discrete and distinct institution. It serves a particular area, has a unique history and is led by a Headteacher, governors and teachers that give specific ethos and direction. The discourse arising from the social relations in this school will be different from that arising from those at any other school. Therefore this research in the first instance must be confined to one school and take the form of a case study. To go beyond that locality would generate variations that would affect the meaning
generated by the discourse. However the findings that are revealed by analysis of the data from this one school should be sufficiently reliable to be applied to other schools in Bedfordshire through the generality given by the methodology and institutionalisation.

It was originally intended that the research processes that will be outlined in section 3.4.3 would be transferred to a second school to test the findings generated through analysis of data produced by the first. However, although permission to carry out research in a second school had been given and preliminary discussions with that school’s Headteacher had begun, the amount of data and subsequent analysis generated by the first school was substantial and sufficient for purpose. Also the generation of the Learner/Teacher Dynamic presented an alternative means of testing the findings as it had arisen out of those of related previous research and an extensive review of the literature for the current research.

3.4.2 Choice of case study

The research was focused on one village school. In line with the philosophical stance of the research, the focus was individuality within the wider context of schools for young children in the United Kingdom. By taking an in-depth approach, the interplay between individuality and structures was studied in detail (Yin, 1984). An ontological and epistemological approach influenced by phenomenology and embraced by institutional ethnography demanded that superficiality should be avoided as the research looked at the dasein of the school, its being as both noun and verb during one short period in time. The researcher considered that Denscombe’s (2003:65) definition of case study was
appropriate:

The logic behind concentrating efforts on one case rather than many is that there may be insights to be gained from looking at the individual case that can have wider implications and, importantly, that would not have come to light through the use of a research strategy that tried to cover a large number of instances - a survey approach. The aim is to illuminate the general by looking at the particular.

A conclusion drawn from consideration of the literature was that individuals constructed their own understanding of external reality. Therefore the relationships between the individuals engaged in learning and teaching, and the processes developed explicitly and implicitly so that learning and teaching can happen, could not be over-emphasised. Methodologies that were directed at delivering outcomes, for example experiments or surveys, will not be used in this study. Indeed the outcome had already been revealed by the literature review: that mathematics is considered by many to be difficult. This research was concerned with discovering why this is so. Therefore it would be concerned with the factors involved in the learning, teaching and assessment of mathematics and the relationships between them with a focus on the role of linguistics. This demanded a case study approach. As the research was also ethnographical, disturbance to the natural setting would be kept to a minimum.

It would be useful for clarity for the research questions to be addressed by the methodology to be restated at this point:

1. What is the role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the four to nine age range?

2. What is the role of peer-peer language in the learning, teaching and assessment of mathematics for children in the four to nine age range?

3. What are the implications of the insights given by linguistics into the learning, teaching and assessment of mathematics for children in the four to nine age range?
It must be noted that it was the researcher that was engaged with the systematic study of language, not the children, teachers and other adults involved in the learning and teaching of mathematics in the lessons in which data was to be collected. It was expected that children, teachers and other adults engaged in learning and teaching would use language naturally, as in any other social context. Data analysis would not only lead to conclusions and implications related to the use of verbal and written language by children, teachers and other adults in learning and teaching. It would also illuminate the value of a linguistic approach to the learning, teaching and assessment of mathematics for the given age range.

3.4.3 Methodologies

The literature review had confirmed the findings from previous studies carried out by the researcher into the importance of spoken and written language in the learning and teaching of mathematics. It had also extended these findings into a model of the learning, teaching and assessment of mathematics where language could be identified as a bridge in its own right between learner and teacher and as an integral component of two other bridges, those of resource and assessment. Evaluation of the structuralist, pragmatic and integrational approaches to linguistics demonstrated that each supported rather than opposed the other. The review of literature produced evidence that the structuralist linguists’ advocacy of literal meaning was defendable. However the field or context of speech acts as argued by the pragmatists and the totality or *habitus of* each individual involved, both learner and teacher, also contributed to the exchange and growth of meaning and understanding. Therefore the methodologies used in collecting data on the role of language in mathematics education had to be sufficiently eclectic to capture the totality of discourse but also underlying social and individual activity, including nonverbal communication and the use of resources and assessment.
Such an approach was in keeping with the philosophical stance discussed in sections 2.2, 2.4.3 and 3.2. The conclusions of those discussions were that mathematical concepts are not simple thoughts or concepts but are constructions determined by perception. Every individual is always on the point of engagement with the future, in this thesis the future being the field of the mathematics lesson. A child is at any moment being essentially on route from what s/he was, that is his/her mathematical *habitus*, towards what s/he will be, the owner of mathematical cultural capital (Bourdieu, 1992).

The mathematics lesson is an external reality for the children, with which they must engage to learn specified and required aspects of the designated curriculum (see section 2.4.3). It also takes place within a wider external reality in the form of the physical classroom and its resources, the school ambiance, peers, teachers, teaching assistants and other supportive adults (see section 2.5). From these separate but interacting components the child constructs knowledge and understanding for him/herself. As s/he is individual, irreducible and therefore not amenable to conceptualisation and the imposition of rules of behaviour and thought, each child’s construction is unique. Also, in accordance with the same philosophy, a teacher is at the same time constructing his/her own perception of external reality, of which the children he/she teaches are individual components. Therefore to determine the role of language in mathematics, its extent and the consequent implications of linguistics an ethnographic and interpretative approach was required. Such an approach would hold to the fundamental importance of subjective consciousness that is active, gives meaning and provides access to essential structures through reflection and was qualitative in nature.
3.4.4 The choice of both qualitative and quantitative methodologies

However a contradiction requiring resolution presented itself when considering analysis to explore the semantic and pragmatic language used in classroom exchanges. An outcome of the literature review is that literal meaning, as defined by semantic linguists such as Saussure (1983 trans:30), exists. The discussion concluded that the technical language of mathematics is literal because it has precise meanings that can be expressed appropriately as set dictionary definitions. This technical language forms a bank of key vocabulary that must be taught in mathematical lessons (DfES, 1999c). To discover how often this key vocabulary is used, and therefore given opportunity to be embedded in children’s vocabulary and thus structure the learning of mathematics (Vygotsky, 1986 trans.; Sfard, 2008) comparisons are necessary. Thus a seemingly inappropriate quantitative aspect is introduced into the ethnographic perspective taken by this research.

Also discussion in the literature review on the linguistic approach to be adopted by the research identified the sentence or utterance as being the fundamental structure (see section 2.3.5). The concept of syntactical structure appears to be incompatible with a qualitative approach though it is in keeping with the concept of structuring structures as defined by Bourdieu (1990 trans.) However, the discussion in the literature review on pragmatics has demonstrated that analysis incorporating the concept of structure is defensible. To recap, pragmatic linguists maintain that language arises out of shared understanding of meaning, in which literal meaning is embedded. This acts as a springboard for individual linguistic interactions in context. This demands a qualitative approach. However discussion has demonstrated that literal meaning is embedded within the shared meaning fundamental to the pragmatic, qualitative approach. Shared meaning is constructed through mutual understanding of the vocabulary used, a semantic approach, in particular syntactic structures, a structuralist approach, in context.
Particular syntactic structures containing particular vocabulary lend themselves to frequency comparisons which are quantitative. Thus structure out of which meaning in context is constructed combines quantitative and qualitative.

Furthermore, the use of frequency comparisons in this research is justified in that the discussion in the literature review concludes that semantic/structuralist, pragmatic and integrational linguistics should be regarded as supporting and not opposing each other. This being the case, analysis appropriate to the perspective from which each linguistic type is viewed should be used, all under the umbrella of an institutional ethnographic and qualitative approach. It must be remembered that the technology used to collect data has been developed in response to the institutional ethnographic perspective of the research. The use of quantitative analysis under this umbrella is necessitated by an outcome of the literature review, namely that the three linguistic stances explored supported, not opposed, each other. Therefore the use of quantitative analysis should be seen as supporting the qualitative integrational analysis, the analysis regarded as fundamental in the research design, and not opposing it.

Content analysis will provide an appropriate methodology by which to explore the utterance and interview data (Hosti, 1968; Brenner et al., 1085; Neuendorf, 2002). Content analysis is an indepth technique that can be quantitative or qualitative. It is based on a scientific approach as discussed in section 3.1. The types of variables that may be measured or the context in which the messages are created or presented are not limited. Content analysis enables the researcher to include large amounts of textual information and systematically identify its properties, e.g. the frequencies of most used key words, phrases or themes. A further step in analysis is the distinction between dictionary-based (quantitative) approaches and qualitative approaches. Semantic, dictionary-
based approaches set up a list of categories derived from the frequency list of words and control the distribution of words and their respective categories over the texts. Analysis of key words and utterances will follow be analysed quantitatively. While methods in quantitative content analysis in this way transform observations of found categories into quantitative statistical data, the qualitative content analysis focuses more on the intentionality and its implications. Analysis of the interview data will take this approach. Section 4.1.1.2 discusses the process following Brenner et al. (1985) in detail.

It is recognized that in disassembling discourse into key words, individual utterances and interview categories some of the unifying structure that gives meaning to discourse will be lost. Nevertheless, the process will enable both the identification of the other-orientedness and the different intentions that could be carried by the vehicle of utterance (Searle, 1979; Toolan, 1996, Wertsch, 1998). Once the utterance analysis had been completed, the insights gained will be carried forward for secondary analysis through triangulation with the outcomes of the word and total speech analysis and the Learner/Teacher Dynamic. Thus the unified structure, the meanings of its various components having been revealed, will be reassembled. Through this process greater understanding of the role of language in the learning, teaching and assessment of mathematics will be achieved.

The totality of classroom interactions will be analysed through discourse analysis. This is a generic methodology for: ‘analysing the choices of words and actions that members of a group use to engage with each other within and across time, action and activity’. Difference between sub-methods can be determined by the type of analysis used. Linguists, or applied linguists, analyse written texts using codes to determine grammatical structures (Stubbs, 1983). Conversation
analysts transcribe recordings of everyday talk and analyze them in terms of the social actions performed in turn taking. Parker (1992) and Sfard (2001) use no particular procedure of detailed analysis, but look for patterns of language use that can be related to broader themes of social structure and ideological critical evaluation. As this research is focused on the structural roles of teacher and pupils manifested through language, particularly in relation to power, the latter approach will be adopted. Transcripts will consist of typed sequenced interactions between teacher, teaching assistant and pupils with non-verbal factors recorded. Video data and transcripts will be studied for themes of social structure, ideologies and comparison with findings from the literature review. A DVD of extracts illustrating the analysis will be included in the appendices (Appendix U).

The conclusion gained from the discussion above is that learning and teaching is a dynamic process for all concerned. This presents questions additional and subsidiary to those forming the focus of the research. The answers to these will involve analysis of both linguistic and non-verbal factors:

1. How does a teacher know that his/her teaching has been successful in terms of a child has learnt according to the learning objectives of the mathematics lesson?
2. How accurate is this assessment?
3. Is the teacher’s assessment of what has been learned the same as the child’s perception of what s/he has learnt?

The development of an appropriate paradigm and its associated methodologies will now be discussed in relation to the author’s previous research.

3.5 Developing an appropriate method of data collection

3.5.1 Pre-MA TTA funded research

In this research into the relationship between teacher confidence and achievement in mathematics (Price and Raiker, 2000) the researcher had taken a
predominantly positive approach. The hallmarks of such an objective approach are explanation, prediction and proof. The related methodologies were quantitative as they were focused on providing measurable variables to provide provable propositions. Clearly methodologies associated with this paradigm, such as surveys, questionnaires and experiments are not appropriate as the determining stance for the current work as the data collected by them is not of the required depth and richness or disturbs the natural flow of events.

The one qualitative method used in this research was that of interview. Tape recorders were used to record the discourse. The technology was piloted and the quietest rooms in the research schools were chosen for the interviews. Despite this, the researcher encountered problems using the technology, including those of distance, the lowering of voices and extraneous noise making the discourse inaudible (Price and Raiker, 2000). Also the typing of transcripts was time-consuming and laborious. The experience in this research affected the choice of methods for the Master’s dissertation.

3.5.2 Master’s research

My Master’s research into the role of spoken language in the learning, teaching and assessment of mathematics was qualitative in nature. The change of stance from positivist to an interpretative paradigm had developed as a result of my growing perception that the teaching and learning process was multi-faceted, complex, dynamic and interactive. This demanded an interpretative approach. The research took apart this phenomenon of language to examine its component parts. These became variables in the study. The aim of the methodologies used was to reveal how all the parts worked together to form a whole. The researcher empathises with Merriam (1998) when she wrote of qualitative research as an umbrella concept covering several forms of inquiry that helped to explain the meaning of social phenomena with as little disruption of the natural setting as
possible, and on which the focus of the study is on interpretation and meaning.

The methodologies adopted for this research were based on the researcher sitting quietly as a participant observer with the sample groups and writing unstructured observational notes during the course of the lesson. Additional data was collected through an adaptation of concept mapping techniques. Interactions between teacher/pupil and pupil/pupil proceeded as closely to normality as possible. The analysis of the mathematical vocabulary collected was one that allowed the formation of categories but was sensitive to the nuances of spoken language. Discourse and content analysis fulfilled these criteria (Brenner et al., 1985; Gee and Green, 1998). The findings were then related back to the overall social structure of the classroom activities observed of which the researcher was also a member. This approach was ethnomethodological in that it accorded with Benson and Hughes’s (1983:175) statement that: ‘One of ethnomethodological interests is the explication of ways in which members, through their practice, produce a social structure of everyday activities, the aim being to describe those activities and show how they work’. As will be discussed below, discourse and content analysis will play a part in the current research and for similar reasons.

The principal method of collecting data for this research was note-taking by the researcher as participant observer. This method was chosen because of the experiences above, the paradigm taken by the researcher and because only one lesson per class was to be observed. Experience gained whilst collecting data for assignments leading up to my Master’s research had shown that the technology available at the time would have caused distraction because of being intrusive in terms of size and the necessity for a technician to be in and out of the classroom to operate it. Also a record of whole class discourse as well as that between individuals in the sample group was required and only one video camera was available to cover the whole class. Although the method was piloted difficulties occurred occasionally. For example when children talked at once, it was difficult
to separate and record the different discourses. This was also the case when one teacher talked very quickly. However an advantage of this approach was the opportunity to record synchronised speech, actions, and non-verbal communication. Also, the method allowed the researcher to act as a participant observer. From within the particular social structure of education, she was able to collect and interpret data revealed by language, yet relate it to the overall social structure of everyday activities of which she was also a member. This ethnographic perspective (Gee and Green, 2007) reflects Bourdieus concepts of *habitus* and field (see section 2.3.5). Therefore it was considered to be appropriate for the current research with its emphasis on the totality of speech acts. The researcher, sitting quietly in the classroom, would not only be taking notes of events and interactions. She would also be able to record the ambiance, the ‘feel’ of the field and note the events and interactions that created it. Further developments in the researcher’s philosophical position since the Master’s research demanded that the methodology must incorporate Heideggerian thought with its greater emphasis on the process of change through being. To reflect this, the concept of participant observer would be expanded (Cohen, Manion and Morrison (2005). Teachers, teaching assistants and children could also be participant observers by being shown digital recordings (see below) and being asked to comment on their perceptions of events and interactions that take place. This would be incorporated into the interviews following the showing of the recordings (see section 3.6.5).

In the Master’s research, the researcher acknowledged that, with an ethnographic, approach there was a danger that the data could be incomplete or misleading. Bias could creep in because of the subjectivity of the approach (Bernstein, 1974, Cavendish, 1990). To meet the former criticism the researcher devised a method of shorthand to accurately capture the discourse. However, although much of the discourse was recorded, there were still substantial gaps in
the record of non-verbal interactions. Also the research was targeted on focus
groups, and not the dynamics of the class as a whole. Therefore this
methodology, although ethnographic in approach, would not be suitable for the
current research in the same way as it was for the Master’s research as it would
not address the holistic philosophy on which the present study is based.

The latter criticism of subjectivity and bias was more difficult to address. The
strength of the stance taken wherein the very fact that the researcher could
observe as an 'insider' became a weakness in that she has been produced by
the same social process. Therefore it was impossible for the researcher to be
objective. This was same argument that prevented the researcher from taking on
the purely phenomenological approach that would be most congruent with
Heidegger (see section 2.3.6). The researcher maintained at the time that as
long as this danger was realised and acknowledged, the self-evident effects
could form part of understanding the social behaviour manifested in the research
setting. The problems of validity and reliability would then become little different
to those encountered when analysing transcripts of interviews or schedules of
The criticism of bias could be addressed by acknowledging it. For there to be no
bias, that is pure information transfer, there would have to be such control of the
variables that there could be no human interpretation at all. This was clearly
impossible. Even the results of the most rigorous scientific experiments ultimately
conclude in human interpretation. So it had to be recognised that there would be
some degree of bias which must be recognised and controlled as far as possible
in line with the underlying philosophy and hence conception of the current
research (Strauss and Corbin, 1990). As this involved encounters with features of
everyday life in the context of formal schooling, the focus would be on
relationships and processes. It would be acknowledged that these were so
interconnected and interrelated that the degree that they could be isolated and
controlled in terms of eradicating bias would be limited. However steps could be taken to maximise the levels of relationships, trust, honesty, understanding and commitment (Toolan, 1996) between the researcher, teachers, teaching assistants and children. These are detailed in the sections below and, as has already been suggested, become part of the final interpretation. It can be seen, therefore, that the statement of the author’s philosophical stance is of fundamental importance to the current research.

3.6 Current research

The literature review concluded that mathematics and language are abstractions, descriptions and externalisations of what the mind perceives in the external world. Mathematics is communicated by and understood through socio-cultural language until the symbolic language of language is mastered. Language is problematic because words are open to interpretation. Therefore learning in mathematics cannot be determined by a study of the language used in isolation. From the literature it appeared that other factors, non-verbal factors, had to be taken into account if a more accurate assessment of the effectiveness learning and teaching is to be achieved. The totality of what occurs in a mathematics lesson cannot be identified through the traditional qualitative data collection methods of face to face interview and observations alone. A more eclectic method of data collection was required. This was provided by technology used in the film and music industries involving synchronised video and sound recording from multiple positions around the classroom (see section 3.6.2) in addition to interview, study of school documentation, note-taking whist acting as a participant observer and the keeping of field notes.

3.6.1 Validity

The validity, reliability and trustworthiness of the data collected as part of this study are essential if it is to make a serious contribution to knowledge in
education. James Tooley amplifies this in *Educational Research-a critique* (1998) by observing that empirical research, based on the premise that reliable knowledge can only originate in experience not acquisition, requires triangulation in order to establish trustworthiness.

Establishing validity is a complicated process. Its complexity comes from the subdivisions within both internal and external factors. Internal validity is achieved when the findings are true for a particular context and research question (Cohen, *et al.*, 2005). The requirements of external validity are met if the findings from the research can be generalised, in other words are they applicable in other contexts and with other subjects? It can be threatened by many factors, for example history, maturation, regression to the mean, testing effects, selection, wastage, the use of unreliable instruments or tests. All of these are addressed by the paradigm and methods chosen. Because of the holistic nature of the research’s case study approach external validity is more difficult to achieve (Strauss and Corbin, 1990). True external validity can only be tested if all schools were studied according to the paradigm and methodology and the findings generalised. This is clearly impossible, but a significant step can be taken in this direction by relating the findings from the data analysis to the Learner/Teacher Dynamic (see section 2.7) and critically evaluating similarities and differences.

Triangulation is achieved by using two or more methods of data collection and/or analysis in the study of some aspect of human behaviour. Such a multimethod approach helps minimise bias and method-boundness. For this research the methods of observation, interview, note-taking as participant observer, field notes and the study of documentation have been chosen in line with the ethnographic stance underpinning it.
Validity occurs when the methodology addresses the research and every measure is taken to minimise bias. Sources of bias in ethnographic research are the characteristics of the observer/interviewer, the characteristics of those observed/interviewed and the nature of the observation/content of the questions. It has already been argued that subjectivity cannot be eradicated from research, but it can be minimised. It has also been argued that individual subjects can come to a higher state of awareness and mutual understanding through discussion.

Embedded within the methodology of this research, and in accordance with Bourdieu’s theory of *habitus* and *field*, is the requirement that all participants (teachers, teaching assistants, learning support assistants and children) should take ownership of the research by being involved in the preparation for the research. This position also requires that participants as well as the researcher should be given the opportunity to express their interpretations of classroom events and interactions, and that these interpretations should be integrated fully into the data analysis. As well as being observed, participants will be interviewed as an integral part of the analysis of the recorded observations.

### 3.6.2 Reliability

Reliability entails the skill of creating a research instrument that will produce similar results wherever it is used. The researcher’s role as Faculty e-learning Coordinator in her post-1992 university has enabled her to work with various technologies as part of her work. Technology has developed enormously since the researcher’s use of video and audio recording equipment in earlier research. Video cameras are now small and unobtrusive. Recordings can be played back immediately after the event. They are reliable, robust and can be activated discretely and without attracting attention from a distance through wireless
technology. Microphones are also small, robust and can be concealed easily (the ethical aspects of using this equipment are discussed below. Also the technician can operate the equipment from outside the classroom being studied, thus lessening intrusion on the natural flow of the lesson.

Technology enhances reliability because, once set up to perform in a particular manner, it will do so in any and every context until reset or it malfunctions.

Experiences in developing a video production and editing facility for tutors and students to produce their own material for teaching and learning was the stimulus for the researcher to consider a means of capturing the totality of events in a mathematics lesson as the principal data collection for this research. Various financial and workload issues slowed down the genesis of appropriate equipment but the requirements were quickly established. For the data collection to be consistent with the philosophical approach it was necessary for as much of the classroom as possible to be covered by wireless cameras and audio equipment. This equipment had to be time synchronised and configured to communicate with a distant server. The data from each camera and audio source had to be recorded discretely, so that detailed analysis could take place, but also able to be displayed as one, so that holistic analysis was possible. This was achieved through a multi-input digital mixer similar to those used to record music performances for video production. The mixer was stationed in the computer suite away from the classrooms where the observations were taking place. Data collected through the mixer could then be stored on a computer, then burnt onto DVD for analysis. The researcher could not operate the equipment in the computer suite and take notes in the classroom so a colleague specialising in audio-visual technology was enlisted to help.
The author acknowledges the truth of Cohen and Manion (2002:282) in their quotation of Kitwood (1977): 'In proportion to the extent to which 'reliability' is enhanced by rationalization, 'validity' would decrease.' However it is argued that the robust structure of the methodology devised for this research would allow both reliability and internal validity to be maximised.

3.6.3 Ethics

At the heart of the ethics of research in education is informed consent. Diener and Crandall (cited in Cohen and Manion, 2000:51) phrase this succinctly as: 'the procedures in which individuals choose whether to participate in an investigation after being informed of facts that would be likely to influence their decisions'.

<table>
<thead>
<tr>
<th>Date</th>
<th>Event</th>
<th>Purpose</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>25-09-06</td>
<td>Governors’ meeting School X.</td>
<td>To ask for approval to carry out the research in the school.</td>
<td>Approval given. Noted in the minutes of the meeting.</td>
</tr>
<tr>
<td>04-10-06</td>
<td>Letter to Head.</td>
<td>To formally request access to the school for research purposes.</td>
<td>Approval given. See Appendix......</td>
</tr>
<tr>
<td>06-10-06</td>
<td>Meeting between researcher, AV technician, teachers and teaching assistants at School X.</td>
<td>To present the research. To demonstrate the AV equipment. To gain their support.</td>
<td>Approval given. Informed research consent forms distributed, signed and returned.</td>
</tr>
<tr>
<td>06-10-06</td>
<td>Meeting with parents at the school.</td>
<td>To present the research in terms that would emphasise the benefits to the children’s mathematical education.</td>
<td>Only three parents came. They were interested, supportive and pleased they had been given the opportunity to ask questions.</td>
</tr>
<tr>
<td>16-10-06</td>
<td>Meeting with Head of School X.</td>
<td>To finalise details of research days.</td>
<td>Details of research days finalised.</td>
</tr>
<tr>
<td>22-10-06</td>
<td>Visits to Classes 1, 2 and 3</td>
<td>Demonstrate the AV equipment Pilot AV equipment, including mixing unit, laptop and server.</td>
<td>Children became familiar with the equipment.</td>
</tr>
<tr>
<td>29-10-06</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>5-11-06</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 3: Record of meetings with the research school

It can be assumed that participants will be exposed to some psychological stress by being involved in the research. Therefore it is necessary for them to be
informed that their involvement at any point of the research is voluntary and that they have the right to refuse to take part and to withdraw at any stage (Frankfort-Nachmias and Nachmias, 2000). Also the aims and purposes of the research should be made clear to them before the start of and during the research (Bell, 2005).

Then the researcher approached the Headteacher and Chair of Governors of the research school for their permission to present the proposed research at a Governors’ meeting on 23rd September 2006 (Table 3). The Headteacher and a senior member of staff were present at this meeting and with the other governors agreed that the research should take place. A series of meetings was then held with members of staff, parents and children (ibid.), the purpose being to inform and also to foster co-operation in line with the philosophy underpinning the research.

During these meetings the confidentiality of the participants’ engagement with the research and the maintenance of their anonymity within the thesis was emphasised (Kimmel, 1998). Cohen et al. (2000:61) define anonymity as follows:

The essence of anonymity is that information provided by participants should in no way reveal their identity…. a participant or subject is therefore considered anonymous when a researcher or another person cannot identify the participant or subject from the information provided.

Frankfort-Nachmias and Nachmias (2000) discussed the strategy of deleting identifiers, for example names and other means of identification. This strategy was adopted by the researcher. Participants were also advised that the results of the research would be given to them, individually and in presentation to the
governors at an appropriate termly meeting. The school would also be given the DVDs containing the observations for their records.

All members of staff were given a letter of consent to sign (see Appendix F) and were given a statement of their rights to confidentiality, anonymity and dissemination (Diener and Crandall, 1978). A letter was sent out to all parents requesting their permission for their children to take part in the research (Appendix F). Ethics approvals for this research can be found in Appendix G.

3.6.4 Maintaining the natural flow of the lessons

In accordance with the phenomenological stance established for the research, it was necessary to minimise the disruption to the natural flow of the lesson. The lesson could be disturbed by the presence of the AV technician, the presence of the technology, and the Hawthorn effect on the lesson participants resulting in them acting unusually when being recorded. The following steps were taken to achieve minimal of disruption:

- The researcher went into the school and attended meetings and assemblies, and visited the classes to be filmed and where she would be taking notes;

- The AV technician accompanied the researcher on three occasions into each of the three classes. The purpose of this was for staff and children to become accustomed to the technician’s presence and that of the equipment. Staff and children were familiar with the researcher being in the classroom as an observer as she had already carried out this role as a governor and link tutor observing student teachers.

- The cameras and microphones were as small as possible and wireless. This also met Health and Safety requirements;

- The cameras and microphones were demonstrated to the staff before the research day. They were able to film, wear the personal microphones and see/hear playback. The purpose of this was for the staff to become accustomed to the equipment and seeing themselves on film. Also this was part of the process of giving ownership of the research to them in accordance with the underlying concept of the research as a totality;
- Likewise, and for the same reasons, the cameras and microphones were also shown to the children on the day the equipment was placed in the classroom. They were able to film and see playback.

- The equipment was installed in the classroom for two days before the research took place. The purpose of this was to embed the equipment within the fabric of the classroom, thus minimising the disruption of the natural flow of the lesson;

- The AV technician operated the equipment from outside the classroom to minimise the Hawthorn effect;

- The children knew where the equipment was placed and that it would be operated but not when. This also minimised the Hawthorn effect.

Approximately six hours of data was collected following this process.

3.6.5 Interviews

This research is concerned with teachers, teaching assistants and children in the social and educational environment of the classroom. Teachers and teaching assistants teach directly or indirectly through language. The interview is a principal means of gathering data through language for analysis (Brenner et al., 1985; Kvale, 1996; Denscombe, 2003, Cohen et al., 2005). Styles of interview range from the formal, akin to the questionnaire, through the less formal where the interviewer can modify the sequence and content of the questions, to the completely informal conversation. To this must be added the non-directive interview, which derives from the therapeutic or psychiatric interview (Partington, 2001 online). The questionnaire which is designed predominantly to obtain responses to a limited number of predetermined answers is a research tool aligned with the positivist paradigm and therefore inappropriate for this study. The non-directive interview was discounted because there are specified research questions to be addressed so the discussion has got to be, to a certain extent, directed. Of the remaining methods, the semi-structured focused interview was chosen. The term ‘focused’ refers to the fact that all the interviewees would have been involved in a particular situation, namely the learning and teaching of mathematics and language according to the CGFS, The National Curriculum and
The Primary Framework, the learning of which is assessed by early years’ benchmarking tests and national tests at seven and eleven.

Research on interviews as a research methodology has demonstrated that individuals respond differently according to how they perceive the interviewer (Bogdan and Biklen, 1992; Lewis, 1992; Kvale, 1996). Sex, age, social class, religion, educational qualifications, professional expertise and ethnic origin can all affect the amount of information given and its honesty. Both researcher and participants have their own preferences and prejudices. These would affect the relationship out of which the information arises. The establishment of an ambience of mutual trust and respect was seen as being crucial to the emergence of rich, meaningful, valid data, the analysis of which will address the research questions (Hitchcock and Hughes, 1995). It was assumed that such an establishment of trust, with the concomitant expression of individuals’ daseins, would minimise the tendency for the researcher to see her subject in her own image and to seek answers that support preconceived ideas. There would be less opportunity for the researcher to misunderstand what the participants are saying to her or for the participants to misunderstand the question being asked.

The success of this approach depended on the researcher developing relationships with the governors, Headteacher, teachers, teaching assistants and pupils. This relationship was based on the participants’ perceptions of the researcher’s credentials to support and develop their learning. The steps taken to achieve this rapport have been outlined in Table 3 and have been expanded throughout this chapter. It must be stated at this point that the researcher had already established a professional rapport with the Headteacher, members of staff and children through her role as governor and link tutor. However this required expansion, assimilation and accommodation of the new role of researcher as discussed in section 3.2.
The Headteacher, teachers and teaching assistants were interviewed individually. They asked not to be videoed but agreed to the interviews being audio recorded. Approximately four hours of data was collected in this way. The children were interviewed as a class following the showing of the recordings. This method was chosen because it mirrored everyday question and answer sessions in class, the aim being to maintain the natural flow of the lessons as much as possible (Wood, 1999). The group approach made identification of individual issues difficult but was less intimidating for the children. It was anticipated that the children would stimulate each other and generate a wider range of responses than if interviewed individually (Lewis, 1992). The cameras were left running during the class interview with the aim of capturing any non-verbal communication. Approximately one hour of data was collected in this way.

### 3.6.6 Pilots

Two pilots using the cameras and microphones were carried out. The first took place in the researcher’s university with a colleague delivering a session on observation to a group of year 2 students as part of their module on Research Skills. The equipment had been purchased piecemeal over time and used discretely by other tutors on their various modules. This was the first time the equipment had been used as an entity. Four cameras were set up on tripods and four microphones placed on the tables on which the cameras were focused. All equipment wirelessly was operated from another room approximately 100 metres away. Also in this room was the upgraded laptop on which the data from both video and audio sources was to be recorded. At a very early stage the laptop crashed. Although it had been upgraded for purpose it could not cope with the amount of data from the different sources. The AV technician quickly found a server from another room and reconnected the video and audio sources to it. This was successful. The cameras and microphones had been synchronised by the tutor clapping his hands, a well-known method of gaining attention of children.
in school and therefore appropriate. Following the session the recordings were displayed on monitors with the related sound. The quality of sound and resolution of video was excellent. Individuals could easily be identified by sight and sound.

The second pilot took place at School X with activity in each class being recorded during one lunchtime. Cameras and microphones were placed in positions. The recording equipment was positioned in the computer suite which was away from the classrooms. Teachers, teaching assistants and children moved in and out of the classrooms whilst the pilot recording took place. Everything worked in Classes 2 and 3 but not in Class 1 where the audio signals were not received by the mixing unit. It was deduced that the number of brick walls between the computer suite and Class 1 prevented the audio signals being received. The AV technician, therefore, recorded from the back of his four-wheel drive car parked outside Class 1.

The interview schedules (Appendix H) were piloted with colleagues at the university and their children. This resulted in some simplification of the adult schedules as two questions subsumed the subsequent questions. The Class 2 and 3 children’s interviews remained unchanged, but on the advice of the Headteacher it was decided that the schedule for Class 1 might require adaption in light of these very young children’s responses.

3.6.7 Documentation

There are various definitions of documentation. Cohen et al. (2005) consider documentation to be somewhat eclectic in that accounts are included as well as written historical data. Hitchcock and Hughes (1995:212) define the source as being ‘mainly written texts which relate to some aspect of the social world’. They include official documents, diaries, letters and photographs. It would appear that
the video/audio recordings of the electronic methodology described above could also be covered in this category. Hitchcock and Hughes go on to classify documentation according to accessibility. However Yin (1984:87) distinguishes by definition and example between documentation and archival records whilst Lincoln (1985) classify documents in terms of whether the text was written with the intention of formalising a transaction, the principal division therefore being between records and documents. The definition of documentation appears to depend on the stance of the researcher and the nature of his/her research. For example Yin and Moore (1983) carried out a case study into nine research and development projects as part of a federal funded activity. For this, such documents as project proposals, interim reports and working papers, completed manuscripts and reprints, correspondence and agenda were examined. These were all encapsulated by the timescale of the research and were current in terms of the research brief laid down by the federal paymaster. Other documentation, such as service and organisational records, survey data and personal records such as diaries and calendars were considered to be archival. This approach whereby documentation is categorised was not appropriate for this research. In line with Heidegger’s tenet that past, present and future are all part of the dynamic called *dasein*, this research considered all documentation to do with the dynamic under scrutiny— that is, the school, staff and pupils, and the processes and relationships that define them— as an integral part of this research into language and mathematics. As the ultimate focus is on children’s learning of mathematics in School X, all documentation to do with the children and adults observed in the learning/teaching/assessment interactions connected with mathematics and language that was made available was taken into account. These included official documents relating to educational policy issued by both national and local authorities, and other texts concerned with education and training. Data given in the school’s SEF, School Development Plan (SDP), SATs
reports, School Improvement Partner reports (SIP), Ofsted reports, Headteacher reports and by teacher assessment was included and considered.
4 Data Analysis

4.1 Interviews

4.1.1 Interviews with adults

4.1.1.1 Introduction

Six members of staff were interviewed, providing approximately four hours of data. They were the Headteacher, the senior teacher in Class 3, a newly qualified teacher in Class 2, an unqualified teacher in Class 1 and two teaching assistants. The Headteacher taught all classes on a regular basis whilst their teachers undertook their statutory non-contact time for planning, preparation and assessment. All interviewees were given the relevant interview schedule some days before the interview so that they had the opportunity to familiarise themselves with the questions. It was anticipated that this would produce richer data. At the time of the interviews the teaching assistants were working in Classes 2 and 3. All interviewees asked for their interviews not to be videoed but they were happy for them to be audio recorded. The researcher took notes during each interview. The researcher’s watch was synchronised with the timer on the audio recorder so that the notes, particularly on non-verbal communication, could be inserted into the interview transcripts subsequently. This was one step taken by the researcher to move from what May (2000) terms ‘endogenous reflexivity’, that is a sense of self arising from all past experiences and influences, to that of ‘referential reflexivity’, where the researcher restructures her sense of self through assimilation and accommodation of the reflexivities of others. This is essential to essential objectivity in interpretative research.
To further develop inferential reflexivity the interviewees were asked where they would like the interviews to take place. The Headteacher chose her office and the other interviewees their classrooms. Each interview began with several minutes of informal conversation which was not recorded. Again this was done to develop inferential reflexivity.

4.1.1.2 Rationale for content analysis

In previous research, Hycner’s (1985) procedures for analysing interview data had been adopted. This phenomenological approach was considered for this research but discounted because critical reflection on Heidegger’s ‘authenticity’ and Toolan’s total speech theory had resulted in a withdrawal from a purely phenomenological approach towards an ethnographic stance (see section 3.4.1). Brenner et al.’s (1985) approach to content analysis was adopted for this research because its course had already followed the first five of their thirteen step process (see Appendix I) and therefore appeared to be in line with its ethos. Previous research, associated literature reviews in addition to the literature review for the current research and the researcher’s experiences as governor had provided the necessary detailed briefing required by Brenner et al., that is understanding the focus and its context in detail and associating with other work that has been done in the same area. The sample was justified on the grounds that, being a small school, all teaching personnel could be interviewed and should be interviewed to provide a reasonable size of sample. Steps 4 and 5, hypothesis development and testing, had been addressed because the current research was an extension and development of my Master’s research (Raiker, 2000). The next step involved immersion in the data. This was achieved by listening to the audio recordings and reading the transcripts several times to interpret an overall sense of the content. This was followed by a process of assigning codes to all utterances in the transcripts (see Appendix J) according to their meaning, initially under the questions (Table 4 below) to which the
utterances were a response. This subjective process was objectified by providing a colleague unconnected with the research with samples from the transcripts and the related coded units of meaning at various points in the process. This resulted in some codes and units of meaning being amended or amalgamated with others as overlaps were identified.

<table>
<thead>
<tr>
<th>Question</th>
<th>Question Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>What do you understand by the word ‘language’?</td>
</tr>
<tr>
<td>2</td>
<td>How important do you think language is for you as a teacher of numeracy?</td>
</tr>
<tr>
<td>3</td>
<td>In what way do you think language is important?</td>
</tr>
<tr>
<td>4</td>
<td>What else besides language do you think is important in teaching children numeracy?</td>
</tr>
<tr>
<td>5</td>
<td>Is it important that the children get the opportunity to talk in numeracy lessons?</td>
</tr>
<tr>
<td>6</td>
<td>When should they be encouraged to talk?</td>
</tr>
<tr>
<td>7</td>
<td>In your view, what are the key assessments carried out to ascertain attainment in numeracy?</td>
</tr>
<tr>
<td>8</td>
<td>Do you think that assessments carried out in class, including SATs, accurately capture a child’s attainment in numeracy? (HT only)</td>
</tr>
<tr>
<td>9</td>
<td>How do you know that a child has learnt according to the learning objectives of the mathematics lesson?</td>
</tr>
<tr>
<td>10</td>
<td>How accurate do you think is this assessment?</td>
</tr>
<tr>
<td>11</td>
<td>Is there anything else you would like to say about language and numeracy?</td>
</tr>
</tbody>
</table>

Table 4: The interview questions to adult participants

The diversity of language resulting from the differing roles, responsibilities and experiences of the interviewees made the process of assigning underlying meanings to groups of responses in order to identify categories problematic. However, the factors determining an institutional ethnographic perspective facilitated this process because content was given structure through those factors, for example, the statutory and non-statutory structures provided by the institution of education and adopted by Bedfordshire schools in accordance with Local Education Authority guidelines (LEA. See section 3.4). That these factors had been assimilated and accommodated by the interviewees to become part of their thinking was demonstrated by the theme ‘National Documentation’ (See Appendix K: Table 12) subsuming only eight responses though their observed practice demonstrated compliance. Also the discourse had as its focus the
learning, teaching and assessment of mathematics in a classroom setting, itself a very structured habitus (Bourdieu, 1989). The subcategories were added to and amended following reflection on the data and the development of interpretations and meanings. Brenner et al. term this process ‘incubation’. The subcategories were eventually confirmed as valid by the same colleague involved in verifying the codes. The process was completed by subcategories being assigned to thirteen themes arising out of reflection on the underlying meanings of the subcategories. This again was confirmed by external scrutiny. The above process accorded with Brenner et al.’s steps 6, 7 and 8. The process detailed in sections 4.1.1.3 to 4.1.3 below complete Brenner et al.’s thirteen steps.

4.1.1.3 Themes

The themes and the number of responses encompassed by each theme are displayed in Figure 4.

![Figure 4: Themes and responses](image)

Most responses were assigned to the theme ‘Teacher generated language in maths’. The figure displaying the subcategories and units of meaning for this
theme can be found in Appendix K: Table 5. The dominance of spoken language in this theme and its related subcategories was striking. Teachers clearly understood the importance of language as a vehicle for teaching and learning. This dominance also confirmed Althusser’s (1971) approach to power as a discursive phenomenon, in which discourse operates by constructing specific positions for speaker and listener (see section 2.3.7). This was also observed by Ben-Zvi and Sfard (2007). This approach is further confirmed by the number of responses, encompassed by the theme ‘Peer-peer language and mathematics’ being less than half those assigned to ‘Teacher generated language in maths’. However there was nothing in the interviewees responses to show that they understood the power of the dialogic approach (Alexander, 2004b; Mercer and Littleton, 2007) in learning.

The table displaying the subcategories and units of meaning for ‘Peer-peer language and mathematics’ can be found in Appendix K: Table 6. Again spoken language dominates. The interviewees clearly saw value in peer-peer talk but it is interesting to note that fourteen out of the thirty-eight responses in the principal subcategory ‘Purposes of talking to peers’ were under the unit of meaning ‘Allows teacher to assess’, signifying teacher control and not the development of collaborative literacy (Israel et al., 2007) and transfer of power that enables achievement through group work (Baines, Blatchford and Kutnick, 2009). Also under this theme appears the subcategory ‘Listening to peers’ with ten responses. Listening is part of the phrase ‘Speaking and listening’ that appears in The National Curriculum (1999a) and The Primary Framework (2006a). The dominance of ‘speaking’ in ‘speaking and listening’ is indicated by its primary position in the phrase. However the dominance of responses concerning speaking over those of listening in the content analysis suggests that the interviewees attach substantially more importance to speaking than to listening despite listening being an essential prerequisite for speaking. Converting what is
learnt by listening to speech involves memory, one of the elements of other-orientedness identified by Toolan (1996) as underpinning the ability of humans to satisfy their need to communicate with each other (see section 2.3.5). Total speech analysis (see section 4.4) indicates that listening was regarded by teachers and teaching assistants as an implicit skill that was tested indirectly through assessment. Unlike speaking, it was not explicitly practised.

The theme ‘Resources, mathematics and language’ attracted the lowest number of responses (see Appendix K: Table 8). This is a cause for concern because, as Ball (1992: 47) points out: ‘although kinaesthetic experience can enhance perception and thinking, understanding does not travel through the fingertips and up the arm’ and as MacLellan (1997) argues, talk stimulated by the practitioner enables children to engage effectively with the resource and make appropriate links with the related mathematical concept. Language and resources are the essential mediators in learning identified by Wertsch (2007). The theme ‘Resources general’ encompassed forty-five responses, the third lowest in the thirteen themes despite Question 4 being designed to elicit data on resources and Questions 5, 6, 9 and 11 all providing opportunities for resources to be discussed. Although all interviewees responded that resources were important in mathematics and judged mathematics to be ‘a practical activity’ (forty responses: see Appendix K: Table 2 for the theme ‘Mathematics general’), the low response rate on both themes concerned with resources suggested that interviewees were unclear on the role of resources and how they could be used effectively. This confirmed Ahmed et al.’s work (2004) showing that many teachers involved in their research did not fully understand how resources related to the mathematical concepts being taught (see section 2.5.1).

Interviewees clearly saw the value of language in assessment. Of the three themes connected with assessment that were identified, ‘Assessment,
mathematics and language’ subsumed fifty-six responses (See Appendix K: Table 11) of which thirty-eight were assigned to the subcategory ‘Purposes of spoken language’. It is interesting to note that ‘Purposes of written language’ occurs under this theme but with only five responses and under the assessment related theme ‘Assessment mathematics’ (See Appendix K: Table 10) with only one response. Reference to written language appeared also under the theme ‘Language general’ in the subcategory ‘Other’ with one response (See Appendix K: Table 1). The low response rate on written language is a finding of this content analysis. It is significant because written work was a feature of all lessons observed. There appeared to be a mismatch between interviewees placing little value, in terms of number of responses, on written assessment with what appeared to be an essential aspect of classroom practice. However the three themes associated with assessment totalled ninety-six responses, indicating that assessment had high priority in interviewees’ thinking. This confirms the identification of assessment as an essential bridge in the Learner/Teacher Dynamic.

Although written language had a low profile in interviewees’ responses, higher value was placed on non-verbal communication, reflecting Crawford et al.’s (1997) emphasis on its importance (see section 2.3.5). Non-verbal communication appeared as twenty-three responses subsumed under the theme ‘Language general’ (see Appendix K: Table 1) but was not perceived to be mathematics related. Interviewees talked about non-verbal communication in relation to themselves, not the children. As the Class 1 teacher said in relation to non-verbal communication in her interview ‘I think it’s really important to engage them and to keep them there. I want it to be as much fun and exciting as it could be, stimulating, all that sort of thing’. This was an example of Manke’s (1997) collusive strategies whereby teachers decrease the social distance between teacher and learner to maintain control and create a learning environment where
the curriculum can be delivered in a ‘fun’ and ‘stimulating’ way in return for the pupils’ attention. The phrase ‘and to keep them there’ indicates control.

It was not anticipated that a theme on behaviour, subsuming thirty-five responses, would arise from the content analysis. Ten responses were assigned to the subcategory ‘Class rules’. The remaining responses were concerned with ‘Confidence’, ‘Motivation’, ‘Esteem’, ‘Emotional Development’ and ‘Responsibility’. None of the questions were designed to elicit data on these subcategories. They arose naturally in the interviewees’ conversation. Although not extensive, these responses indicate interviewees’ concern for the personal, social and emotional welfare of their pupils and their awareness that these factors influence learning. It is acknowledged again that this research’s focus on the role of language in the learning, teaching and assessment of mathematics excludes examination in detail of these factors but it is significant that the interviewees acknowledged their importance.

4.1.1.4 Subcategories

Table 5 presents all responses in excess of ten subsumed by various subcategories and themes. The predominance of spoken language, in that it occurs in five out of the six categories with the most responses, has already been discussed. This table allows the identification of the interviewees’ awareness of the importance of language in general and to mathematics in particular, though the number of responses is not high, being thirteen and twelve respectively.

It is interesting to note that interviewees were aware that mathematics was ‘a special language’ (twenty-eight responses) and that it provided ‘common meaning’ (ten responses) but there is less understanding of its specificity (eleven responses). This was identified throughout the literature as a potential area of difficulty (for example, see section 2.3.5) and by the interviewees themselves in
that eleven responses were subsumed by the subcategory ‘Issues with mathematical language’.

<table>
<thead>
<tr>
<th>Theme</th>
<th>Subcategory</th>
<th>Responses</th>
</tr>
</thead>
<tbody>
<tr>
<td>Teacher generated language in maths</td>
<td>Children’s use of spoken language with teacher</td>
<td>46</td>
</tr>
<tr>
<td>Mathematics general</td>
<td>A practical activity</td>
<td>40</td>
</tr>
<tr>
<td>Assessment, mathematics and language</td>
<td>Purposes of spoken language</td>
<td>38</td>
</tr>
<tr>
<td>Peer-peer language and mathematics</td>
<td>Purposes of talking to peers</td>
<td>38</td>
</tr>
<tr>
<td>Teacher generated language in maths</td>
<td>Teachers’ use of spoken language with children</td>
<td>32</td>
</tr>
<tr>
<td>Teacher generated language in maths</td>
<td>Spoken language in planning of the lesson</td>
<td>30</td>
</tr>
<tr>
<td>Language general</td>
<td>A special language</td>
<td>28</td>
</tr>
<tr>
<td>Language general</td>
<td>Non-verbal communication</td>
<td>23</td>
</tr>
<tr>
<td>Language general</td>
<td>Individuality of language</td>
<td>21</td>
</tr>
<tr>
<td>Teacher generated language in maths</td>
<td>Enables personalised learning</td>
<td>15</td>
</tr>
<tr>
<td>Resources general</td>
<td>Visual resources</td>
<td>14</td>
</tr>
<tr>
<td>Language general</td>
<td>Importance of language</td>
<td>13</td>
</tr>
<tr>
<td>Resources general</td>
<td>Important for maths</td>
<td>12</td>
</tr>
<tr>
<td>The maths teacher</td>
<td>Feelings about maths</td>
<td>11</td>
</tr>
<tr>
<td>Language mathematics</td>
<td>A specific language</td>
<td>11</td>
</tr>
<tr>
<td>Language general</td>
<td>Issues with mathematics language</td>
<td>11</td>
</tr>
<tr>
<td>Language mathematics</td>
<td>Common meaning</td>
<td>10</td>
</tr>
<tr>
<td>Behaviour</td>
<td>Class rules</td>
<td>10</td>
</tr>
<tr>
<td>Peer-peer language and mathematics</td>
<td>Listening to peers</td>
<td>10</td>
</tr>
</tbody>
</table>

Table 5: Subcategories attracting ten or more responses
Although the themes concerning resources were placed in low positions in terms of total responses (‘Resources, mathematics and language’ attracting six responses and ‘Resources general attracting forty-five), two subcategories are represented in the table. This raised the profile of interviewee awareness of the importance of using resources, particularly visual resources, in the learning and teaching of mathematics but not of the importance of using language with resources (see section 2.5.1). It reflects Pimm’s (1995) observation that meaning lies closer to resources than understanding of the underpinning language.

The subcategories on ‘Individuality of language’ (twenty-one responses) and ‘Enables personalised learning’ (fifteen responses) demonstrated interviewees’ awareness of language and learning being individual (Vygotsky, 1987) and reflects their concern for the personal, social and emotional well-being of the child. These responses together with the eleven responses to ‘Issues with mathematics’ which are all about language also reflect specifically a pragmatic and integrational linguistic approach whereas ‘Common meaning’ and the one response each to the units of meaning ‘Common code’ and ‘Same meaning’ encompassed by the subcategory ‘A specific language’ within the theme ‘Language general’ (see Appendix K: Table 1) reflected the structuralist linguistic approach (see sections 2.3.4 to 2.3.6). Therefore for these interviewees the balance of linguistic approach lay with diversity and not with commonality in language. As both Pimm (1995) and Ben-Zvi and Sfard (2007) point out that the establishment of norms in language is essential for children to gain access to the genre of mathematics, this is a cause for concern.

### 4.1.1.5 Units of meaning

173 units of meaning were identified attracting 606 responses. From these forty-eight subcategories were identified. Nineteen of these are presented in Table 5 representing subcategories with ten or more responses. A total of 413 responses were subsumed by these nineteen subcategories. The remaining twenty-nine
subcategories subsumed the remaining 193 responses. Twenty-two units of meaning came under the subcategory 'Other’ as they did not have sufficient similarity to be grouped as subcategories. Although the twenty-nine subcategories attracted less than ten responses some of them are of interest to this study. Whereas subcategories with over ten responses demonstrated common awareness of particular issues across the interviewees, those attracting less than ten responses demonstrated that one or more of the interviewees had awareness of some aspect of the learning, teaching and assessment of mathematics, or that one interviewee was particularly aware of some aspect. For example, the four responses subsumed by the subcategory 'Accuracy of assessment’ within the theme ‘Assessment, mathematics and language’ were responses of the Class 1 teacher. The seven responses within the subcategory ‘Motivation’ within the theme ‘Behaviour’ were responses from the Class 1 and 3 teachers and the teaching assistant working in Class 3. Of particular interest are the five responses to the unit of meaning ‘Not good at maths’ subsumed by the subcategory ‘Difficulties with mathematics’ within the theme ‘The mathematics teacher’. These responses came from the Headteacher, the Class 1 and 2 teachers and the teaching assistant in Class 2. This demonstrated that the findings of research carried out in the 1980s and 1990s by various researchers (sees section 1.1) that many lower school teachers found difficulty with mathematics is still an issue with these interviewees. It is worth noting here that the one teacher who did not admit to having difficulties with mathematics, the teacher in Class 3, was the least secure of all the interviewees in her subject knowledge (see sections 4.4.3 and 4.4.4). Although she was at ease in her interview and answered questions knowledgeably and at length, the video recordings of her teaching mathematics demonstrated what may be termed confident incompetence. This presents an issue for threshold concept theory as an individual’s arrival in liminal space appears to depend on her/him realising s/he is ‘stuck’ (Perkins, 1999; Meyer and Land, 2005; see section 2.4.5).
'Confident incompetents' do not realise they are stuck and therefore will neither seek help nor make an attempt to address their areas requiring development. What is more they well not realize that their pupils will experience difficulties that occur because of their instruction and some will succeed in spite of that instruction (Ben-Yehuda et al. 2005).

4.1.2 Interviews with children

The responses of the children to the class interview questions are to be found in Appendix L. They are not as extensive as was anticipated for a number of reasons. As has been indicated, the class interviews took place after the children had been shown approximately five minutes per group of the observation video. Class 1 was shown part of their lesson on positioning which they undertook on the carpet (see section 4.4.2 and Appendix U video clip 2). Their non-verbal communication suggested that they were fascinated at seeing themselves, watching avidly and quietly (Crawford et al., 1998; Ruthrof, 2000). Because only six children were present, the whole class was regarded as one group. The response to the question ‘What good stuff were you learning about this morning?’ was ‘Fireworks, we were painting fireworks over there!’ When a gentle prompt brought their attention to the teddy and the box used by the Class 1 teacher to demonstrate what ‘side’ and inside’ and ‘back’ meant (see the transcript at Appendix M for details of this lesson), some of the children were able to give some of the position words introduced by the teacher. However there was clear confusion on the meaning of the words ‘side’ and ‘back’, a difficulty caused by the teacher (Ben-Yehuda et al., 2005). This will be discussed in depth in section 4.4.2. The children’s responses indicated that they knew that they came to school to learn but it is questionable whether they knew precisely what they were learning in their mathematics lesson.
Class 2 was shown fifteen minutes of video, five minutes of each group after which the interview questions were directed to that group. The responses were very short. Their non-verbal communication suggested that they had had enough of this particular mathematics lesson. However there were some interesting answers. In answer to the question ‘What have you learnt today?’ three of the seven responses were about procedures to record their mathematics, for example ‘We learnt how to draw round triangles’. The prominence of language concerning procedures and not mathematical content will be discussed in section 4.3.6 and 4.3.7 on the analysis of utterances and will confirm Mercer’s (2000) and Smith et al.’s (2004) observations that patterns of teacher/pupil discourse have not changed fundamentally from an IRF approach. Two of the answers concerned words describing shapes, the subject of the lesson, and the remaining answer simply comprised the word ‘Pictures’. In answer to the question: ‘How do you know you’ve learnt about shapes?’, two of the eight answers concerned the amount of work completed, four were about writing, one was about drawing round the shapes and the remainder was ‘I know faces and edges and sides and points’. It should be noted here that study of the documentation revealed that the mathematics policy had not been reviewed since September 2002 and therefore did not contain any reference to assessment for learning and its focus on sharing learning intentions and success criteria. However the teacher did in fact have the learning intention as the title to her Powerpoint presentation. Nevertheless there was no clear indication from the children’s responses that they knew what they were intended to learn and that they had in fact learnt what they were intended to learn, a necessity for meaningful participation in the activity (Seifert, 2002).

The responses from Class 3 were more in number and in length though their first response to seeing themselves on screen was hilarity, amply confirmed by their non-verbal communication. Because of this the video shown to the four groups was only a couple of minutes each. The responses from the children
demonstrated, as they were older, their increased ability to communicate their perceptions of learning. The Year 3 children provided five responses to the question ‘What did you learn today?’ One reflected the younger children in Class 2 in his answer ‘I didn’t finish my work’. For another, alternative interpretations are possible. His answer was: ‘I got my pencil stuck in there’. This could be interpreted as learning being unimportant to him, or as an attempt to deflect attention from his inability to articulate precisely what he had learnt. This exemplifies the necessity of interpretation being undertaken with caution. The remaining three answers were about counting in twos, constructing the two times table and recording their work. One of the learning intentions of the lesson, shared by the teacher with the children, was to recap multiplication as repeated addition so these three Year 3s understood what they were intended to learn. It should be noted that these children were supported in their work by the class teacher and the teaching assistant.

The Year 4 children, who worked unsupported, were less focused in their replies. The six answers were all different. Examples were ‘Turn sums into smaller ones’; ‘With the harder ones the number line was a bit easier’; and ‘I learnt to double it each time because I pushed the number along to the next one’. None of these, or the remaining answers to be found in Appendix L, are congruent with the learning intention to recap multiplication as repeated addition. As Seifert (2002) observed, the group has to know something to do with the purpose of the group to enable learning. The Year 3 children’s answers to the question ‘How do you know that you have learnt?’ revealed greater understanding of the learning process than did those given by Class 2. Examples were: ‘I knew what to do and it was easy’ and ‘That you understand and don’t need any help’. Examples of the Year 4 children’s responses were: ‘Because when a teacher or someone asks you a question you know the answer’ and ‘I know what I’ve learnt because when I start it looks really impossible and I think what? Because you suddenly remember what to do about
it, and I started and I could do it’. This reflects the transfer of mastery noted by Bruner (1996) necessary for deep learning to occur. Interestingly, four of the twelve responses were about Mrs. C, the teacher, explaining what to do which meant that the children could then do the work. However, as the total speech analysis revealed (see section 4.4.4), the Year 4 children to whom Mrs. C explained the work but did not talk about it between themselves completed their work inaccurately; those to whom Mrs. C explained the work and talked about it as a group presented correct work. This supports Vygotsky’s (1986 trans.) primacy of the social in learning and also Baines, Blatchford and Kutnik’s (2009) assertion that group work raises achievement. It is interesting to note that the interviewees provided only one response on the importance of subject knowledge and only seven responses on the necessity of teachers having a good mathematics vocabulary (see Appendix K: Table 4).

4.2 Word analysis

4.2.1 Introduction

An outcome of the literature review was that a structuralist approach to language would be beneficial for the learners of mathematics because it holds that individual words in a language are endowed with a defined set of meanings such as those to be found in a dictionary. This is confirmed by Pimm (1995) Cobb (2000) and Ben-Zvi and Sfard (2007) whose research has demonstrated that symbols and their meanings must be mutually constitutive and merger together as normalised language for learners to access the genre of mathematics. To recap, structuralist theory maintains that words are combined by a set of rules, that is, grammar, whereby the individual meanings of the words are merged to form the meanings of utterances. The meanings of these utterances are then combined to form the meaning of speech or text. Speakers use a fixed biplanar code to communicate whereby reified grammatical forms are linked to fixed meanings such as those provided by dictionaries (see section 2.3.4). Although
the branch of structuralist linguistics called semantics admits that context has some place as knowledge for literal meaning, it is disregarded on the grounds that this background knowledge is too variable to be analysed meaningfully. It was argued that this approach resonates strongly with the prescriptive, centrally structured and controlled National Curriculum and Primary Strategy. Application of this theory to a mathematics lesson suggests that, with appropriate effort and attention children and practitioners can understand each other, misconceptions can be defined, identified and corrected, and absolute evidence of learning having occurred can be collected. However, the literature review indicated that a structuralist approach did not reflect children's natural use of language. A more accurate approach to children's speech is given by pragmatics wherein the differences in meaning brought by individuals to speech events and interactions in context are acknowledged (see section 2.3.5).

Furthermore total speech theory (Toolan, 1996) and dialogic inquiry (Wells, 1999) reflects *habitus* and *dasein* (see section 2.3.6). This is essential for understanding in curriculum areas such as literacy, the arts and humanities. In mathematics and the sciences precision and accuracy of expression are required. However it has been argued that, in the early phases of mathematical learning, the language of mathematics is embedded in context of use in the early phases until pupils make the transition to the abstract symbolic language of mathematics. It appears that, in order to provide insights on the structuralist, pragmatic and integrational aspects of language used in mathematics lessons, the data from classroom recordings of lessons must be subjected to both word and content analysis. Analysis of the words used will provide evidence of the types of words used by teachers and learners, that is, whether they have single or multiple meanings. Content analysis will indicate whether the words combined grammatically into utterances are meaningful in structuralist, pragmatic or integrational terms.
4.2.2 Development of Shuard and Rothery’s categorisation of words.

4.2.2.1 Rationale for choice

The discourse analysis used in my Master’s research (Raiker, 2000) began by identifying and quantifying the different words and phrases used by teachers and children to express mathematics during the course of the observed lessons (see section 1.1). These were then sorted into words and phrases contained or not contained in the National Numeracy Strategy’s Mathematical Vocabulary (1999c). This document was published at the same time as the National Numeracy Strategy (1999a). The in-service training (INSET) of teachers in the introduction of the National Numeracy Strategy included reference to Mathematical Vocabulary. Emphasis was placed on what was termed ‘the correct use of mathematical vocabulary’ because better numeracy standards occurred when teachers, among other practices, ‘use and expect pupils to use correct mathematical vocabulary and notation’ (1999c:5).

The final sort was using a development of Shuard and Rothery’s categorization (1984) of words into everyday, lexical and technical categories. To recap, technical words have been defined by the writer as words that have a precise meaning in English that was mathematical only, for example ‘algebra’, ‘calculus’ or ‘hexagon’. Lexical words are those that had a similar meaning in mathematical English as in everyday English. Examples of these are ‘equal’, ‘parts’ and ‘altogether’. Everyday words are words that occurred both in everyday English and mathematical English but could have similar and different meanings in mathematical English from their meaning in everyday English, for example ‘difference’, ‘table’ and ‘odd’. Because the experience of analysing words using the development of Shuard and Rothery categorisation was found to be useful, it was adopted for this research. However, the review of literature undertaken for the current research has provided the insight that mathematical words have nuances of meaning including the denotive. Therefore the development of
Shuard and Rothery categorization assumes a lower profile than it did in my Master’s research (Raiker, 2000).

4.2.2.2 Validity of findings of Master’s research

Word analysis would also provide indications on the validity of the findings of the Master’s research (Raiker, 2000). These were that technical words were used the least by all groups; lexical words and everyday words were used more frequently than technical words by all groups; everyday words were used more frequently than technical words for all groups; and lexical words were used more often than any other category for all groups. Number words were omitted in the Master’s research (Raiker, 2000) from the range of words counted because they are lexical words but also the fundamental technical words of mathematics. Number words are either being taught, as in Reception, or are known. When they are known they are used frequently and their inclusion would mask the frequency of other less fundamental technical and lexical words. To enable comparison, number words were omitted from the range of words analysed in this research. Number words arose naturally as a subset in the Master’s research. They did so in the current research in the utterance category ‘Answers to teachers’ and will be discussed in section 6.1 below.

4.2.2.3 Findings of the Master’s research

The predominance of words whose meaning could be applied accurately in both the real, everyday world and the abstract world of mathematics was clear in the Master’s analysis (Raiker, 2000). Should these findings be replicated by the current research the tenet of structuralist linguistic theorists that words have literal meaning would receive further confirmation (see section 2.3.4). Technical mathematical words are also clearly semantic in that they have fixed meanings. In the Master’s research they were the least used words. Everyday words having different meanings in the real world from the mathematical world were used more
frequently. These words confirm the validity of a pragmatic approach which stresses the embeddedness of meanings. The literature review concluded that such words might cause confusion for young mathematicians (see section 2.4.6). As both pupils and teacher bring their own meanings of words embedded in their own individual experiences into lessons (Vygotsky, 1986 trans.; Wertsch, 2007) analysis of the pragmatic language could indicate points when misunderstandings and misconceptions might arise (see section 2.3.5). The Master’s research Appendix A) revealed that teachers used a wider range of words, varying from forty-eight per cent to 217 per cent more, than the range of words used by the children they taught. Therefore there were more opportunities for problems to arise as many of the words used by teachers were everyday.

Implicit by virtue of the occurrence of lower frequencies is that the ranges of words/phrases used by the sample groups were significantly lower than those used by classes when in dialogue, and that the range of words/phrases used by the sample groups and the classes when in dialogue with the teacher with the teacher were significantly lower than those used by the teachers when addressing her pupils. Ironically, this suggested that in peer-peer interaction there was less opportunity for misunderstandings to arise. As the current research is considering the role of teacher-generated and peer-peer language in the learning, teaching and assessment of mathematics, similar analyses would be useful.

4.2.2.4 Current research: key word analysis

The collection of words and phrases for analysis in this research differed from that for the Master's analysis (Raiker, 2000) in that in the current research technical, lexical and everyday mathematical words used throughout the lessons were counted. ‘Words’ in this context means ‘tokens’ not ‘types’ as the total number of words regardless of type was counted (Chandler, 2001). Counting of types would ignore repetitions. For this analysis repetitions were counted (Appendix O). The
counting of phrases was done in the same way. For the purposes of this research ‘phrase’ is defined as two or more words in grammatical order that comprise a syntactic unit.

Another difference is that in two of the classes teaching assistants were working with the children. No teaching assistants were present during the Master’s observations. To present the current research data in the same form as in Appendix A would be confusing. Also such display would not be appropriate for research that is essentially ethnographic. Therefore no direct comparison with the Master’s research was attempted. The current research data was broken down for comparison into the range of words used during the whole class input, teacher/group interaction, teaching assistant/group interaction, self-directed groups compared with groups working with teaching assistants, and self-directed groups compared with groups working with teachers. Again, in response to the ethnographic perspective of the research emphasis has been placed on analysing the role of key words in the mathematics lessons observed. Key words are words or phrases that have been identified by the teacher and/or the scheme of work followed by the teacher as fundamental to the understanding of the mathematical concepts being taught. This was done for the November observations only as trends it quickly became apparent whilst analysing the transcripts. As Strauss and Corbin (1990:30) point out, in qualitative research it is only necessary to transcribe ‘as much as is needed’.

As Appendix N demonstrates, the words and phrases used in Class 1 were focused on the learning intention of the lesson, learning about positioning. The eight key words were used frequently by the teacher in both her class inputs and her work with children applying positioning language to the doll’s house, but they were not used frequently by the children. Four of them were not used at all. A feature of the range of word analysis of this Reception class was how little they
used mathematical words at all. Despite the teacher's encouragement the children spoke little, thus hindering development of fluency (Pimm, 1995). This might have been because they did not understand the application of positioning words applied to the box (in the main teaching input part of the lesson) and the doll's house. The children's body language did not suggest that the presence of the cameras, microphones and researcher affected them. The lack of mathematical talk by these children is an issue if, as was argued in section 2.4.3, mathematics is verbal language for children in the early phases of education. As Cobb (2000) observes, symbolising, communicating and mathematising are at the heart of mathematics education and these children did not appear to be developing any of these three elements. This will be discussed further in the section 4.4.2 on total speech analysis.

In Class 2 the range of words used by the teacher is similar in number to the range of words used by the children in her group. However analysis of the words used demonstrated that seventeen out of the twenty-four used by the teacher and twenty-two by the children were the same (Appendix O). Of these seventeen, ten were technical words, the subject specific language of mathematics. Of the remaining words, four were key words. This teacher was working with her group to ensure language was used correctly. However not all words were used by teacher and children more than once. For example the key word ‘point’ was used only once by teacher and group, whereas the word ‘pyramid’ was used eight times by the teacher and twelve times by the group. The general word ‘shape’ was used twenty-six times by the teacher and only once by the group. Although this teacher was aware of the necessity to use language correctly, opportunities for reinforcement passed unnoticed. This was confirmed by the frequent use of deictic expressions, an important finding that will be discussed in detail below (Yule, 1006) . The lack of key language
reinforcement in the current research confirmed the same finding in the Master's research (see section 1.1).

The more limited range of words used by the teacher in Class 3 runs counter to the trend outlined above. This could be interpreted as the teacher focusing on encouraging the children to talk rather than on her own exposition. There were eleven key words given in the downloaded lesson plan used by this teacher, of which only ‘add(ing)’ was used by both teacher (twelve times) and children (fourteen times). Of the other non-key mathematical words only five were used by both teacher and the group. The most frequent was ‘equals/equal 2’ which was used six times by the teacher and three times by the group, and ‘three times’ by both teacher and group. The learning intention of this lesson for her group was to revise multiplication as repeated addition. The word ‘multiplication’ was used three times by the teacher but not at all by her group. The phrase ‘repeated addition’ was not used by either teacher or group. The word ‘multiply’ was used once by the group but not at all by the teacher. The children talked more than the teacher but it appears that encouraging and reinforcing the correct use of mathematical language was not a focus for this teacher.

The trend of adults using a wider range of words than the children with whom they were working was followed by the teaching assistants and their groups in Classes 2 and 3. The teaching assistant in Class 2 was working with Year 1 children on two dimensional shapes whilst the teacher worked with her group on three dimensional shapes. Although the range of mathematical words used by teaching assistant and teacher in Class 2 is similar, the actual words and phrases differed though there was parallel emphasis on the words ‘count’ (seven and eight repetitions respectively) and ‘shape’ (forty-one and twenty-six) and the phrase ‘how many’ (fifteen and nineteen). However the teaching assistant was not as successful as her teacher in encouraging the children with whom she was working
to repeat mathematical words. Of the two key words appertaining to her learning intention, ‘side(s)’ and ‘face(s)’, there was only one repetition of the former and none of the latter. Of the twenty-five words and phrases used by the teaching assistant only nine were repeated by the children. The most frequent was the general word ‘shape(s)’ which was used forty-one times by the teaching assistant and six times by the group. The next most frequent word was ‘triangle, used eight and four times respectively. The potential for children to forget subject specific vocabulary because of lack of repetition and thus inhibit fluency (Pimm, 1995; Sfard, 2008) is clear. This would confirm the findings of my Master’s research.

Both the range of words used by the teaching assistant and her group in Class 3 was more restricted than those in Class 2. However, whereas the teaching assistant was working with all the Year 2 children, the teaching assistant in Class 3 was working with two less able Year 4 children. Therefore a narrower range would be appropriate. Although working on multiplication as repeated addition was the learning intention for this group, ‘repeated addition’ was not used at by either teaching assistant or children; ‘multiply(ing)’ was used three times by the teaching assistant but not at all by the children, and ‘multiplication’ was used by neither. It would appear that these teaching assistants need to be made aware that key vocabulary is to be articulated by both themselves and their pupils so that shared, literal meaning can be established (Cobb, 2000; Ben-Zvi and Sfard, 2007).

In Classes 2 and 3, one group was left to work independently, while in Class 1 five groups were left to work independently. The self-directed groups in Class 1 were painting (Chpg), using the mathematics program on the class computer (ChICT), sorting bugs (Chbugs), playing with the model farm (Chmf), and letter writing (Chlw). It is clear how little mathematical language of any kind was generated by these Class 1 self-directed groups. Cross-checking with the March
observation revealed the same outcome in the self-directed groups. It appeared that mathematical language would not automatically be used by young children placed in play situations with potential for generating mathematical language. It also seems that the involvement of a practitioner is necessary to generate subject specific language. As Wertsch (2002) points out the use of teacher/pupil dyads is essential to enable children to be inducted into the genre of mathematics. There was no evidence in these observations, or in those of this class in March 2007, mathematics arose out of, as Gardner maintains, ‘a confrontation with the world of objects’ (1984:128). Instead it appeared that children were not aware of the mathematics around them until words were given to specific patterns and operations by more knowledgeable others; in Class 1 these were the teacher and teaching assistant. The number of variables indicated in previous discussion in the groups led by teachers and teaching assistants in Classes 2 and 3 render further comparisons of this data unhelpful.

4.2.2.5 Deictic expressions

So far the discussion has centred on the varying success of practitioner and learner using key words to establish shared, literal meaning, that is, fixed meaning defined by the teacher and exemplifying the power relations between them (see section 2.3.7). This indicated a structuralist/semantic approach to language that was in keeping with the precision of mathematics. As the key words used in Nov/Class 2 were being analysed, the emphasis on deictic expressions became evident. As discussed in section 2.3.5, deixis means pointing with words. Any linguistic form used to achieve such pointing is termed a deictic expression. They can be used to indicate people (‘me’, ‘you’), location (‘here’, ‘there’) and time (‘now’, ‘then’). These are termed in order person deixis, spatial deixis and temporal deixis.
Deictic expressions contain a dimension of distance in that they can denote relative distance from the speaker. For example ‘this’, ‘here’ and ‘now’ are proximal to the speaker whereas ‘that’, ‘there’ and ‘then’ are distal, away from the speaker (Yule, 1996). All are associated with a pragmatic approach to linguistics because they depend on the speaker and hearer sharing the same context. This is at variance with the structuralist/semantic approach and, being grounded in context and thus not biplanar in mode, presents possibilities for misinterpretation. Possibly more important is that the use of deictic expressions may stand in for subject specific mathematical vocabulary. As has already been suggested, children in the observations were not being given the opportunity to practise the vocabulary of their mathematical focus, thus delaying, even obstructing, their mastery of the language of mathematics. As has been shown, the teacher in Class 2 ensured that her children practised the correct mathematical terminology although her overuse of the word ‘shape’ in place of words with greater precision missed opportunities for further repetition of subject specific vocabulary. However this teacher used ‘it’ sixty-five times, the same number of times the word was used by the self-directed Group 3. If the subject specific words ‘it’ replaced had been used by the teacher, her group would have had substantially more practice of mathematic vocabulary and hence develop fluency (Pimm, 1995).

4.2.2.6 Development of Shuard and Rothery analysis

This analysis involved sorting the mathematical words and phrases recorded in the three observations into technical, lexical and everyday categories. To maintain objectivity, the lists were shown to two fellow educationalists. Differing views on the categories into which words should be placed were debated and a consensus reached. Categories are denoted in the columns entitled ‘S&R category’ on the spreadsheets to be found in Appendix O.
The results of the developed Shuard and Rothery analysis for the Master’s research are clearly demonstrated that technical words were used least (see Appendix A). However it could be argued that this was to be expected as technical words for any subject area form a small subset of the total vocabulary available for individuals. The predominance of lexical words was also to be expected for the same reason. That they have the same meaning in mathematical and everyday English is evidence for the existence of literal meaning. However the fact that they were embedded within the substantial presence of everyday words presented ample opportunities for misinterpretation, and shifted words away from being items in a structuralist code towards being interpretative based on context, *habitus* and *dasein*, the integrational position (see section 2.3.6).

Mathematical language for my Master’s analysis was collected by note-taking only from the main teacher input and one group activity per lesson observed. For the current research all language used in the observed lessons was video and audio recorded. Mathematical language used by teachers and children during the November observations was separated, categorised and analysed as follows:

- Teacher/children/class input- this included the oral/mental starter, main teacher input and plenary;
- Teacher/group activity
- Teaching assistant/group activity
- Self-directed activities

Relevant data can be found in Appendix P.

*Teacher/children/class input*- mathematical language was categorised into technical, lexical and everyday words used by teachers and children. A further division was made into whether the technical, lexical and everyday words are keywords as given on lesson plans, or, as in the case of Class 1, forming the focus of the lesson.
The same pattern of lexical words predominating with everyday words more frequent than technical words. However, in Classes 1 and 2 the keywords are not technical words and in Class 3 keywords encompass two technical words, one lexical word and eight everyday words.

In Class 1 it can be argued that expanding Reception children’s vocabulary by introducing mathematical applications of everyday and lexical words is vital as the evidence strongly suggests that mathematics is verbal language for children in the early phases of education. However for Classes 2 and 3 it can be argued that key words should be technical words where possible and be used by the teacher where possible. Lexical and everyday words could be used to expand understanding of the technical words to enable individual understanding, particularly during group work (Israel et al., 2007). For example, the key words in Class 2 were the everyday words ‘point’, ‘side’, ‘face’ and ‘edge’. Technical words used in the lesson were, amongst others, ‘rectangle’, ‘pentagon’ and ‘cuboid’. It is suggested that the technical words should be key words, with everyday words and lexical words used subordinately so that understanding is related to the subject specific vocabulary.

*Teacher/group activity-* the majority of words used by the Class 1 teacher were lexical and everyday and contained the key words of the lesson. In comparison, in Class 2 the teacher used predominantly technical and lexical words. It is interesting to note that the children used more technical vocabulary than the teacher. This confirmed the finding of the range of word analysis that the Class 2 teacher was working to ensure that her group were using language correctly, in this case the subject specific language of mathematics. Shuard and Rothery analysis for this teacher and her group’s language shows that the trend of everyday words being used more than technical words but less than lexical words is not confirmed in this class. Everyday words were used least. It is suggested
that this class’s profile is more likely to encourage the assimilation and accommodation of subject specific language than the observed trend. In Class 3 the trend was followed by the group, but the teacher used more everyday words than lexical and technical ones. As has already been pointed out the trend for more everyday words than technical words is undesirable because everyday words present opportunities for misunderstandings to arise whereas technical words do not (see section 2.3.4). This teacher’s predominant use of everyday words is compounding the potential for miscommunication to occur.

There was no teaching assistant in Class 1. The profile of Class 1 follows the trend. The most striking point from this chart is the lack of children’s verbal input. This is also observable in Class 3. However, the teaching assistant in Class 3 used predominantly everyday words as did the teacher whilst working with her group, engendering the same potential problems. An interesting avenue of study would be on the similarities of teaching delivery between teachers and their teaching assistants.

*Self-directed activities*- the mathematical words used by the Class1 children in the five undirected activities were combined as the number was so few. The trend was not followed with everyday words used most frequently. In Reception it has to be applauded that the children were using mathematical words at all in their play. However it must be remembered that four of the five activities had been planned to encourage mathematical language. As has already been observed, this was not going to happen without practitioner stimulation and intervention. It is interesting to note that both the school’s School Improvement Partner Autumn 2007 Visit Report (Appendix Q) and the January 2008 Ofsted report (Appendix R) noted that standards in both language acquisition and calculation were low. The former document noted that there were delays in language development overall
and that some children were having difficulties acquiring language at the expected rates.

A similar observation could have been made of the self-directed group in Class 2 as the data demonstrates the prominence of everyday words. The profiles of the two self-directed groups in Class 3 follow the trend identified in the Master's analysis and confirmed by most of the data analysed for the current research. These groups consist of the Year 4 children. The school deemed them to be a mathematically adept group and this was confirmed by the mid-Key Stage SATs results in which one child received a 4A, one child a 4C, one child a 3A, four children 3B, two children 3C and one child a 1A. The average grade attached to this test is 3B. There has been some discussion already on the difficulties the Class C teacher had with teaching mathematics and this was confirmed by the total speech analysis which is to be found in section 4.4. There is a possibility that the children achieving 3B and above were 'experts' (Piaget, 1972) in that they were mathematically more able and therefore could extract the correct, precise mathematical meaning of a lexical and everyday word and apply it consistently in a mathematical context whereas 'novices', particularly the less able, would have difficulty unless they were supported.

4.3 Utterance analysis

4.3.1 Introduction

The Master's analysis had concentrated on the language of mathematics used in teacher-pupil and peer-peer interactions. Only utterances containing mathematical language as identified and defined by the developed Shuard and Rothery analysis (1984) had been considered in the analysis. As discussed in the previous section on word analysis, mathematical language had been categorized into technical, lexical and everyday words and phrases. Utterances not containing examples of these categories were not considered for analysis. The analysis for
the current research considered all utterances spoken during the lessons. Content analysis following Brenner et al. (1985) was adopted for this utterance analysis according to the rationale outlined in section 4.1.1.2. In brief, following transcription, texts were read and reread. During this process the other-orientedness (Toolan, 1996) of the speaker emerged in expressions of intention, in other words what type of response the speaker expected to receive in return for his/her articulation. As analysis progressed, intentions were grouped where appropriate into categories. The occurrence of intentions was noted. Frequencies were calculated and displayed as bar charts to aid analysis. Clear profiles emerged. It is interesting to note that identification of a subcategory level, as in content analysis of the interview data, was not necessary in the utterance analysis. In section 4.1.1.2 it was acknowledged that the diversity of language resulting from the differing roles, responsibilities and experiences of the interviewees made the process of assigning underlying meanings to groups of responses in order to identify categories problematic. The assignment of intentions to speakers in classroom discourse was also problematic but not to the extent encountered in the interview analysis. In part the institutional ethnographic perspective to this research enabled the process as discussed in section 4.1.1.2 as the institution of education provided structure. The discourse was also more focused in the classroom settings. Intentions were concerned with the learning, teaching and assessment of mathematics and not on the wider issues identified in the interview analysis such as mathematics having a special language or the importance of practical activity. In the classroom, speakers were involved directly with the business of teaching and learning, not theorising about it.

### 4.3.2 Rationale for utterance analysis

The discussion in previous chapters has suggested that a structuralist approach to linguistics might reflect the imperatives of mathematical vocabulary in that it must be precise and not open to interpretation. However an approach that
includes pragmatics and total speech theory invited exploration of the differences in meaning brought by individuals to speech events and interactions in context. A pragmatic and/or integrational approach to language, therefore, does not reflect the needs of mathematical vocabulary (see sections 2.3.5 and 2.3.6). Moreover, the word analysis in the section 4.1 provided evidence for potential problems in the teaching and learning of mathematical concepts. The wide range of everyday and lexical words used by children and teachers suggested increased opportunities for misunderstandings to arise. The review of literature also suggested that teachers used language imprecisely and incorrectly. The analysis of individual words could not provide evidence for either. If there were any, analysis of longer interactions would be necessary to reveal them. Utterance and total speech analysis were the vehicles for this.

Some insight could also be gained into the conclusion reached in the literature review that at least some elements of utterances must convey literal meaning for communication to take place (Pinker, 1994). Examples of such elements are ‘How many…?’; ‘This is a…’; ‘Can you…?’; ‘You’ve got to…?’ However, combined with these literal fragments or phrases are such grammatical features as nouns, verbs, adjectives etc. An example is given by the sentence ‘Have you finished?’ This sentence could be articulated by a teacher at the same time to two pupils working on the same task in the classroom and be interpreted as a polite inquiry or an admonishment depending on the disposition of the hearer and the degree of task completion. Thus these grammatical elements, in the example given a verb, allow the sentence to be interpreted individually and differently depending on context, an approach more aligned with Bakhtin (1981), Toolan (1996) and Wertsch (2007).

Previous discussion (section 3.4.4) has demonstrated that content analysis will provide an appropriate methodology by which to explore the utterance and
interview data (Hosti, 1968; Brenner et al., 1085; Neuendorf, 2002). As the
determining theoretical stance of this research is ethnographic (Hammersley and
Atkinson, 1994) the identification of intentions and categories into which
utterances could be assigned was not determined prior to the analysis. A first
transcript was randomly selected, that of Nov/Class 2/gp1/TA (for details of
classification of individuals, 4.3.3). This recorded the discourse of the Year 1
group in the mixed Year 1/2 class working on a 2D shape activity with a teaching
assistant during the November 2006 observation. The researcher read through
the transcript, carefully considering and then noting down the intention of each
sentence in terms of the meaning it was intended to transmit and to whom.
Repetitions of intentions identified categories. Other transcripts were chosen
randomly and subjected to the same analysis. Very few additional categories
were revealed through the sentence analysis of subsequent discourse. For
example, non-mathematics/procedural unelicited statements (i.e. social language
unrelated to mathematical or procedural issues) to practitioners was identified in
Nov/Class2/gp2/T. Utterances demonstrating confidence and lack of confidence
emerged from the sentence analysis of discourse in Nov/Class3/gr1. These were
added to the list of intentions and explain the zeros entered against some
intentions for particular groups in the charts (Appendix S).

4.3.3 Categorisation of individuals

A simple method of identifying individuals from the transcripts was established as
follows. Two observations took place, in November 2006 and in March 2007. The
first element of the code denotes which month the observation, and its related
transcripts, took place. One lesson in each class was observed at each time. The
Reception class has been given the identifying number 1, the Key Stage 1 class
the identifying number 2, and the Key Stage 2 class the identifying number 3.
Groups were given the numbers already designated by the teacher. Within each
class and group, individuals were identified alphabetically. An example of the
resulting code for an individual child is thus Nov/Class 2/gp1/ Child B, for a
teacher is March/Class3/gp4/Teacher, and for a teaching assistant
March/Class1/gp1/TA.

4.3.4 Categorisation of intentions
The intentions and categories identified are given in Appendix S for both the
analyses of utterances used by teacher/teaching assistant and for those used by
the children. Intentions denote the primary identifications of differences in
purpose of utterances. Categories group intentions with common purpose. For
example, the category ‘Instruction’ in the analysis of a teacher’s utterances
groups instructions that have been identified discretely as being procedural,
mathematical, demonstrational or purposeful, or as couched as suggestions
relating to procedure or mathematics. Intentions that cannot be grouped but
stand in isolation are given the term ‘category’ as further research may identify
other intentions that could be grouped with them. These one-entry categories
would then become intentions under an appropriate category name.

4.3.5 Exemplification of categories
The categories and intentions assigned reflect the roles of the practitioners, that
is teacher or teaching assistant, and the children in the interaction generated by
the whole class during the entire lessons. The practitioners used utterances to
regulate the pace of the lesson and the behaviour of the children. They used
words, known as discourse markers, to signpost that the children should listen as
they were about to give or wanted to receive information important to the
attainment of lesson objectives. ‘Right then’, ‘OK’ and ‘Ready’ were frequently
used examples. Occasionally, practitioners requested information, for example,
‘Has everybody got a new shape?’ Questions termed ‘requests’ were seen as
having different intentions from those used for informal assessment and were
therefore categorised separately.
Formative assessment questions occurred frequently. Such questions were asked to assess the mathematics being learnt, as in ‘Right, how many faces has it got, how many faces?’ and also on the procedures involved in processing the activities in which the mathematics was embedded. Examples of the latter are ‘Are we ready to draw round our shape?’ and ‘Has everybody written down the name of their shape?’ Within the category ‘Informal assessment’, both mathematical and procedural intentions were directed at individuals and to the group or class as a whole. Intentions were perceived as being questions directed at mathematics general (to the whole class), mathematics individual, procedural general and procedural individual. It is pertinent to note here that very few of the formative questions were constructed to elicit the thinking behind answers. They were overwhelmingly of the closed procedure variety encouraging a numerical answer or a single word answer, sometimes accompanied by an indefinite article. This confirmed the findings of Mroz et al. (2000), Smith (2004) and Alexander (2004b) that teachers spent the majority of their time explaining or in using highly structured questions and answers of low cognitive level designed to direct learners’ responses towards the required answers (see section 2.4.7). For example:

Nov/Class3/Teacher: Right, if I double, you'll have to listen, if I double 26, what would the answer be?
Non/Class3/Child J: 52
Nov/Class 2/Teacher: If that was a 2D shape, that would be an oblong, if this was flat, but it's a 3D shape. Child G?
Nov/Class3/Child G: A box?

Discourse extract 1: Examples of closed questions inviting low cognitive answers

Utterances intending to instruct formed a major part of the discourse. A dichotomy was identified in utterances dedicated to informal assessment between those directed at mathematical learning and those intended to maintain correct procedures for recording that learning. Examples of both types are ‘It's
still a triangle. It's just not got the same shape’, and ‘Write down triangle’.

Intentions were also identified for practitioners demonstrating procedures as in
‘Like that’ whilst writing on a small whiteboard. There were also intention types for
purpose, for example ‘I’m going to give you a new shape to do’, and for
suggestion. Suggestions were also categorized into mathematical and
procedural, examples being ‘Let’s see how many faces it has got’ and ‘Shall we
take it out of the plastic and have a look?’

A one-entry category identified was that of eliciting questions such as ‘Can you
feel the edge for me, can you?’ Eliciting questions were not intended to assess
but to encourage children to connect quanta of knowledge, in this case the feel of
an edge and the meaning of the word in a mathematical context. Elicitation has
been identified by Mercer (2000) as an identifier of teacher-led discourse in
opposition to dialogic interaction.

Confirmation was given in various forms of utterance termed follow-up tokens
(Sinclair and Coulthard, 1975), ‘yes’ being the most brief. Again there were
follow-up tokens relating to mathematics:

Nov/Class 2/gp1/Child D  How many faces?
Nov/Class 2/gp1/Child B  Three.
Nov/Class 2/gp1/TA       It’s got three faces, hasn’t it. (Statement not
                         question)

Discourse extract 2: Example of follow-up tokens relating to mathematics

There were also follow-up tokens relating to procedures:

Nov/Class 2/gp1/TA       Well, you need to find the shape on here first.
Nov/Class 2/gp1/Child E  Shapes.
Nov/Class 2/gp1/TA       That’s it!

Discourse extract 3: Example of follow-up tokens relating to procedures
Follow-up tokens related to real life experience as in the following use of a simile:

Nov/Class 2/gp2/Teacher Child E, what's it called, Child E? It's…
Nov/Class 2/gp2/Child A A cone.
Nov/Class 2/gp2/Teacher Yeh! Because it looks like an ice-cream cone!

Discourse extract 4: Example of real life experience follow-up token

Metaphor was also used in confirmation:

Nov/Class 2/gp2/Teacher What shape is it called?
Nov/Class 2/gp2/Child F A cuboid.
Nov/Class 2/gp2/Teacher You're getting the hang of this!

Discourse extract 5: Example of follow-up token demonstrating metaphor

However, the use of metaphor was rare. The term here is used in the linguistic sense and not according to Pimm (1995), namely that language and manipulatives are metaphors in mathematics.

There was less variety in utterances of correction. A simple ‘No’ was used, but there were also examples of longer utterances such as ‘It’s not a sphere. A sphere is a ball. A ball is not a cuboid’. Explanatory utterances were either of the mathematical or procedural variety, examples being ‘This is a cube because it has only got square faces’ and ‘She can’t copy you. She’s got a different shape’. Utterances expressing social convention were of two types, praise as in ‘Brilliant, excellent!’ and politeness tokens as in ‘Thank you very much’. These confirmed Manke’s (1997) identification of discourse strategies with a two-fold intention. Such utterances help to lesson the distance between practitioner and learner and boost the latter’s self-esteem. They can also be regarded as evidence for the collusion that Manke believes is necessary for effective teaching to take place. In the classrooms observed for this research, indirect correction and social pleasantries appeared to be part of the ethos of the school more than strategies to avoid confrontation and loss of teacher control. An interesting avenue for future
research would be to investigate the impact of indirect correction and social pleasantries on children’s behaviour and teachers’ perceptions of control.

The categories and intentions assigned to children’s utterances reflect in part those allocated to teachers’ utterances, confirming Wertsch’s (2002) observation that teacher/child dyads enable the transfer of genre, in this case, that of mathematics. Answers and questions in response to teacher stimuli are to be expected, as are the incomplete utterances of young language learners. However the latter were relatively rare, even in recordings of the discourse of the youngest children aged four. Incomplete utterances were assigned a separate category for such utterances as ‘You have……what is yours?’

There is one category that is not reflected or shared with those of the teachers. This is of particular interest to this study and will be described and exemplified first. The Master’s research provided evidence for collective monologues. This is a term coined by Vygotsky (1986 trans.) for young children’s utterances, both in individual work or play and when in the company of others, that do not appear to be oriented towards another person or persons. There were examples identified in Class 1 and Class 2 but not in Class 3. For example, Nov/Class 2/gp1/Child C held a Perspex pyramid and said without making eye contact with anyone else in the group, ‘I'm looking inside’ to which she received no answering comment or question. Another example from the same child was ‘I’m too tired to do this’ whilst writing in her book. Again there was no comment or answer from either the teacher or the two other children in the group. These are examples of collective monologues concerning procedural issues. There were also collective monologues by the same child on mathematics, for example ‘Three faces dum-de-dum-de-da’ and ‘One edge’, both uttered whilst examining a 3D shape.

Vygotsky claims that children use collective monologues to practise externalizing thoughts in language. It is also possible these children had not fully understood
the rule of communication that one uses gaze to signal intention to communicate (Argyle, 1988; Knapp and Hall, 2006). However, as Vygotsky (1986) observed, collective monologues could be indications of the individualization of socio-cultural learning.

There were also single-entry categories for modality markers, that is, expressions of degrees of uncertainty or confusion such as ‘I can’t do it’. These utterances were identified separately to those expressing lack of confidence such as ‘It’s going to be difficult’. Statements affirming confidence were identified as well, for example ‘I’ve done it’. Examples of all three single-entry categories were infrequent.

An important category for children’s utterances was that of peer interaction. Five differing intention types were identified; for procedural statements, mathematical statements, mathematical questions, procedural questions and statements/questions that were neither procedural nor mathematical, in other words, social talk. This is exemplified in the following discourse:

```
Nov/Class 2/gp2/Child E  Child F, I'll get it out.
Nov/Class 2/gp2/Child F  No, it's stuck, because I'm the one that stuck it. I accidentally stuck it.
Nov/Class 2/gp2/Child E  No, there you go.
Nov/Class 2/gp2/Child F  Doh!
Nov/Class 2/gp2/Child E  Child F, stop saying doh!
Nov/Class 2/gp2/Child C  When she said doh! to me, because of that, I hate that word, Child F!
```

**Discourse extract 6: Example of social talk**

Social talk, that is, talk unconnected with the task of learning (Opie, 1993; Grugeon, 2005), either of mathematics or the procedures associated with it, occurred predominantly when the children were left without adult support to complete their work. This will be discussed further in section 4.4 on total speech.
analysis. The other four categories of peer interaction can be exemplified as follows:

procedural statements: We're supposed to cut out these (Nov/Class 2/gp3/Child C)
mathematical statements: Hey, that's two pyramids! (Nov/Class 2/gp2/Child F)
mathematical questions: Has it got one corner? (Nov/Class 2/gp3/Child B)
procedural questions: Are we allowed to open this out? (Nov/Class 2/gp1/Child A)

**Discourse extract 7: Categories of peer interaction**

Many of the children's utterances contained information in response to the practitioner’s questions. Intention types in the category ‘Answers to teacher’ include single number or answers. In response to the question ‘How many corners has yours got?’ Nov/Class 2/gp1/Child C answered ‘Four’. Single words evidencing subject specific vocabulary were used to answer some questions, for example ‘Oblong’ was uttered by Nov/Class 2/gp2/Child B to his teacher’s question ‘Can you say oblong?’ The practitioner’s questions would also elicit answers as more complex utterances. Nov/Class 2/gp2/T asked ‘What shape are the faces?’ and received the reply ‘Three squares and two triangles’. There were answers to procedural questions. The answer to the teaching assistant’s ‘What do you write down?’ was ‘Its name, its name!’ by Nov/Class 2/gp1/Child G. There was also some social talk.

- Nov/Class 2/gp1/Child B asked, ‘Have you got to do this here? 
- TA replied, ‘Like that, do you see? 
- TA clarified, ‘At the top of your page. 
- Nov/Class 2/gp1/Child B inquired, ‘What, and shapes? 
- TA confirmed, ‘Yes, shapes. 

**Discourse extract 8: Examples of children’s answers demonstrating mathematics and procedures**
Children’s questions to practitioners could be about mathematics or procedures. The following extract contains examples of both. The data showed that there were a greater number of questions about the procedures than the mathematics.

The final category of children’s utterances to be identified was ‘Unelicited statements to teachers’. These could be about mathematics, procedures, or social talk. These differed from collective monologues in that the teacher was directly addressed in the sentence by the use of her name, or by the child looking at the teacher, thus indicating an intention to communicate with her. Examples of the three sub-categories are given below:

**Unelicited mathematical statements:**

This is a cube because its only got all square faces. Nov/Class 2/gp1/Child F

**Unelicited procedural statements:**

Miss, I’m going to do the long date (Nov/Class 2/gp1/Child E

**Social talk:**

It’s like a little house! (Nov/Class 2/gp1/Child F

**Discourse extract 9: Examples of children’s unelicited statements to teachers**

### 4.3.6 Analysis of teacher generated talk during whole class input and of children’s responses

#### 4.3.6.1 Teacher generated talk

Teacher talk is defined as discourse controlled by the teacher. It has a ritual quality in that it takes the form of question or statement and response with the teacher, rarely the children, asking the questions). This confirms the findings of such researchers as McHoul (1978), Edwards and Westgate (1982), Edwards and Mercer (1987), Thornborrow (2002), Mercer and Littleton, 2007) that there is an unequal distribution of rights of discourse between teacher and learner and this manifests itself in an initiation/response/feedback pre-ordained format of discourse (Sinclair and Coultaurd, 1975). This was most clearly seen in the mental/oral starters during both observations in Classes 2 and 3, and in the main teaching input of Class 1. Typical of this form of dialogue is the following extract
from March/Class 1. The learning intention of the lesson was to count forwards to
and backwards from 10 and 20. The extract not only denotes the ritual aspect of
teacher talk but the tendency observed in all sessions for teachers to digress
from the mathematics:

March/Class 1/Teacher: Now I want some help now, to have a little think
for me. Now, I've got a bag of what here?
March/Class 1/Child G: Pennies!
March/Class 1/Teacher: [Patting the floor] Sit on your bottom. Child F?
March/Class 1/Child F: Pennies.
March/Class 1/Teacher: Pennies.
March/Class 1/Child A: You're right they're real, they make a lovely
sound. Can you hear the lovely sound [shaking the bag]?
March/Class 1/Child A: Are they real?
March/Class 1/Teacher: Yes, the toy ones don't make that lovely sound.
Sit on your bottom. Right, who'd like to guess
how many pennies there are in here? There are
quite a few of them. I had to go and ask all the
teachers and collect them all together. How
many, Child F?
March/Class 1/Child F: [Hand up. Counts using fingers] One, two, three,
four, five, six, seven, eight, nine, ten.91
March/Class 1/Teacher: You think ten? What does somebody else think?

Discourse extract 10: Example of initiation/response/feedback discourse

Utterance analysis of the teachers talk is displayed in Appendix S. It can be seen
that there is a discernible shape to the utterances, illustrating the frequency of
sentence types most and least used by teachers. As would be expected, all
teachers used utterances to regulate behaviour (Bentham, 2005; Cheminais,
2006). However the relatively low incidence of this type demonstrates the good
standard of behaviour in the research school. The incidence of praise was
noticeable and this may be a contributory factor.

Both teachers and teaching assistants used discourse markers that were
individual to the practitioner (Knapp and Hall, 2006). It will be recalled that non-
verbal communication was noticeably important in interviewees’ responses,
reflecting Crawford et al.’s (1998) emphasis on this aspect of communication (see
section 2.3.5). Discourse markers were directed at bringing the children’s attention onto what was to come. Class 2/Teacher exemplified good practice in this. Her voice was predominantly soft and calm. She spoke and sat quietly, hands clasped in her lap unless there was something she particularly wanted to emphasise by pointing. When she did this, or uttered ‘Right then’ with enthusiasm and increased volume, the children’s body language responded. Gee and Green (1998) have pointed out that it is not possible to determine the meaning of a word or phrase without considering the way it is said and its context of use. The children clearly understood what was required of them. They looked at her, lifted their heads or leaned forward a little more. In contrast to this, Teacher/Class 3 overused discourse markers. For example, Teacher/Class 3’s discourse recorded in Appendix S shows that she used signposting words or phrases seventy-eight times compared with Class 2/Teacher’s twenty. It was observable that the overuse of discourse markers diluted their effect as the lack of response in the children’s body language indicated that they had become part of the general discourse of the lesson. This teacher’s teaching style was kinaesthetic in that it involved various degrees of movement (Gardner, 1983). Again this diluted the power of gesture to direct the focus of learning.

Teachers demonstrated varying emphases on giving instructions on mathematics and the procedures in which the mathematics was embedded. Apart from the discourse markers for Nov/Class3/Teacher (Gee and Green, 2007), the intention types ‘Instruction Mathematics’ and ‘Instruction Procedures’ accounted for the majority of utterances. These reflects Alexander’s (2001) identification of ‘teaching as transmission’ as a means of inculcating information and skills deemed to be socially and/or economically necessary. The emphases on instruction in these two areas were reflected in the pattern of explanations given. It appears that the teachers’ response was to correct by further instruction rather than address an incorrect answer by making explicit why it was wrong (Mercer,
2000. This could confuse children as they might neither realise their answer is incorrect nor relate the continuing explanation as an attempt to rectify their mistakes (Wells and Montgomery, 1981; Fisher, 1993).

Another feature of the utterances used during the whole class input was their use for eliciting information and for formative assessment (Assessment Reform Group, 1999). In both cases most utterances were connected with mathematics. To reiterate, eliciting questions are defined as those encouraging children to bring to the forefront of their memories information that already has relevance to the teaching in hand. Formative assessment utterances were directed to the class as a whole more than towards specific children. This is in contrast to group work interaction where practitioners targeted individuals more frequently. This demonstrates the value of practitioners working with small numbers.

### 4.3.6.2 Children’s responses

Appendix S contains the charts of the children’s responses. Most striking is the control of these children’s response. As Althusser (1971) pointed out, language is a discursive phenomenon in which discourse operates by constructing specific positions for speaker and listener to occupy. The children’s responses were overwhelmingly in response to teachers’ or teaching assistants’ questions, confirming Mercer’s similar observation (2000). Most frequent are single word answers, either of number or a key word. These closed responses were in answer to closed questions. There were very few instances of articulation of thought processes resulting in a particular answer (Alexander, 2004). Also striking is the children’s greater involvement in Class 2. In this class children were encouraged to use key vocabulary and to indicate understanding by answering questions with a simple ‘Yes’ or ‘No’. Nov/Class 3 demonstrated greater frequency of mathematical statements. As these children were older, it can be surmised that they had had more time to absorb and practise the vocabulary and
syntactical structures of English, and therefore felt more confident in articulating
their answers in this way, demonstrating increasing mastery and fluency (Pimm,
1995; Ben-Zvi and Sfard, 2007). It is interesting to note that, as was found in one
of the preliminary studies to this research, the Year 4 children who preformed
well in the mid-Key Stage test in mathematics also performed well in English
(Appendix T).

The other categories of sentence used by the children during whole class input
were connected to modality markers denoting degrees of uncertainty, that is, with
confusion and confidence. The positive ambiance created by the teachers was
demonstrated by the fact that some children were able to externalise their
emotional responses to the lesson. However in all lessons there were
opportunities for children to be confused or misunderstand but even in Class 3,
where most of these occurred, there were very few expressions of confusion.
Children’s confusions were rarely articulated. There were not many instances of
utterances expressing confusion, confidence or lack of confidence. This does not
mean all such difficulties were revealed. For example, March/Class 3/ Group 1
were clearly confused as no child in the group completed successfully her/his
worksheet on creating a Carroll Diagram according to the verbal instructions
given by their teacher (see section 4.4.4, also Appendix T). However, no child in
the group expressed her/his confusion verbally though there were indications
given by the group’s non-verbal communication that all was not well (Argyle
1988; Knapp and Hall, 2006). It is therefore proposed that more of the children
observed would be having difficulties with the mathematics they were learning,
and that the busy teachers and teaching assistants would have missed
opportunities to address these difficulties. As has been indicated above the
written work done as part of the activities would be another opportunity for
practitioners to identify children needing further support. However the format of
worksheets could be another cause for confusion (see section 4.4.6).
4.3.7 Analysis of teacher/teaching assistant generated talk

Whereas the language used in discourse by the teacher and teaching assistants in all observations was primarily task focused, formal and could be complex, that used by pupils showed two distinct categories. The first was used in answering and asking questions originating from the teacher or teaching assistants, and making unsolicited statements to them or to another child. The other category was peer interactions and is strikingly different from the former. In both, sentence construction was simple and uncomplicated.

4.3.7.1 Analysis of the discourse used by children during practitioner-led activities

The discourse of children during practitioner-led activities reflected that of practitioners in that it was task-focused and formal (Thornborrow, 2002). Discourse in Class 1 produced more real world allusions and talk unrelated to either mathematics or mathematical procedures, but the total amount of discourse was less than that for the other two classes. The evidence is overwhelming that utterances carry literal meaning. The ritual of initiation/response/feedback (Sinclair and Coulthard, 1975; Gee and Green, 2007) was implicitly and explicitly directed at establishing literal meaning. The practitioners’ formative assessment questions stimulated children to give answers. As the charts in Appendix S illustrate, these answers were mostly of the single number variety, single word or phrase, or short, simple utterances. There was evidence of a greater number of mathematical statements from children in the Key Stage 2 class. Questions to the practitioner were simple in structure, for example ‘What do you mean?’ and ‘How many threes?’ from Nov/Class 3/Gp4/Child A. The utterance structures used by the children, even in Class 1, were well-formed and to a large extent complete (Pinker, 1994). As with adult speech there was little hesitation during discourse. The children were not taking time to consider what utterance structure to use, and which words they should choose to transmit their meanings most effectively. Utterances were uttered
automatically. This confirmed the pragmatic approach (Cobb, 2000; Sfard, 2008) that utterances are the fundamental vehicle of speech. This refutes Toolan’s (1996) view that literal meaning does not exist and that all meaning has to be negotiated. However, how to speak in utterances has to be mastered first. Negotiation on meanings of words, however, could take place when children first begin to articulate words. Likewise identification of prototypical short utterances and sentence fragments into which specific vocabulary could be slotted to reflect the sentence context could be discerned at an earlier age (Pinker, 1994). However there was evidence that the ritual teacher question/pupil response serves to develop subject specific vocabulary and sentence formation but not extensively. Cobb (2000) and Sfard (2001) regard this as a necessary prerequisite of mathematical fluency.

Solicited answers and questions to the practitioners were mostly related to mathematics. However, unsolicited statements to the practitioners were predominantly about procedures in Classes 2 and 3. An example from Nov/Class 2/gp2/Child E was ‘You know what, I can open this out!’ and from Nov/Class 2/gp1/Child B ‘She’s copying me!’ The evidence from the utterance suggests that the Key Stage 1 children were more concerned with the procedures of recording being correct than with the mathematics they were learning, suggesting that extrinsic motivation to please (Skinner, 1953) the teacher rather than with the intrinsic motivation (Maslow, 1954) of the pleasure in doing mathematics. Unsolicited statements to the practitioners in Class 1 demonstrated their egocentric stage (Piaget, 1972) of development, for example Nov/Class 1/Child C’s ‘I want that one!’ and ‘I did that one!’

Evidence of social talk was observed during both observations in the Reception Class, in Nov/Class 2/gp3 and Nov/Class 3/gp3. Social talk is defined as talk unrelated to mathematical instruction, or the procedures associated with related
activities, or of their recording (Opie, 1993; Grugeon, 2005). The social talk in Nov/Class 2/gp3 is discussed in depth in section 4.4.5. In Nov/Class 3/gp3 social talk was due to the nature of child L in Nov/Class 3/gp3 who had been diagnosed with Attention Deficit Hyperactivity Disorder (ADHD). However, the March/Class 3 observation revealed no social talk by this child, although his non-verbal behaviour demonstrated over-activity.

Children’s discourse in the practitioner-led groups was focused on the task and predominantly directed at the practitioner. This register of discourse had not been identified in the research questions but was implicit in the institutional ethnographic perspective adopted for this research to provide reliability (Smith, 1987). Its existence became apparent during the course of utterance analysis. It emanates from the practitioners’ control and is related to sentence forms evident in the practitioners’ classroom discourse. For these reasons, the term used in future discussion to describe this type of discourse emanating from children will be ‘classroom talk’.

### 4.3.7.2 Analysis of peer-peer talk

The discourse of the children when a practitioner was not present was dominated by procedural matters, an example of Bourdieu’s (1989) constituting and dynamic structuring structures. As the charts in Appendix S demonstrate, the incidence of utterances on this intention was very high. This reflects the high number of utterances about procedures uttered by the practitioners. The practitioners made explicit their concern that activities and recording should be processed in a prescribed and non-negotiable manner (Althusser, 1971; Sinclair and Coultard, 1975; Smith et al., 2004)). Therefore it is not surprising that the children expressed uncertainty when the practitioners were not there to guide them. However, as Seifert (2002) pointed out, the fundamental prerequisite of group work is for all group members to know something about the purpose of the work
for which the group was created. The analysis has demonstrated that teachers considered procedures to be an important constituent of children’s work and that this was passed on to the children (Wertsch, 2002). However the discourse centred on the mathematical and procedural elements of activities was not carried out as classroom talk as defined above. Though children responded to the stimuli of statement or question the language used was less focused on the mathematical or procedural language evident in the practitioner-led discourse and more on the underlying social relationships. Whereas the practitioner-led discourse reads like a pre-determined script, any reader of the independent group work transcripts would have difficulty in understanding the focus of some of the children’s discussion. Occasionally in some extracts the subject of the discussion itself is unclear. However consideration of the total text clarifies the mathematical focus and therefore such discourse cannot be classified as social talk in this context, that is, talk unconnected with the task of learning, either of mathematics or the procedures associated with it. Sentence analysis had revealed the possibility of a register situated between classroom talk and social talk. As identification was effected by total speech analysis, the evidence for this register new to the research will be discussed in section below on total speech analysis.

4.3.7.3 Analysis of group work

Charts in Appendix S display the types of utterances and their frequencies used by practitioners and learners in Nov/Class 2. The profiles of these charts are similar for all class observations. The most striking result of this exercise is the confirmation of Alexander’s (2001) and Kutnick and Blatchford’s (2003) identification of instruction/exposition modes of interaction though which teaching is enacted in that most sentences used by teachers in group work concern procedures related to the activity through which individual learning is to be achieved and of recording that learning. This dominance of procedural discourse
is mirrored in the confirmation of procedures in response to children’s questions. Procedural dominance was most evident in the discourse of Class3/teacher and Class3/TA, clearly demonstrating that the teacher determines class pedagogy. The longer the teacher worked with a group of children, the more discourse was centred on procedural matters. A typical example of practitioner discourse at the start of the group activity is as follows:

> Are you listening everybody? Listening, Child E? Our instructions say ‘Draw round a shape.’ So we’re going to take a shape from here and we’re going to draw round it with our pencil and then we’re going to count the sides. Now, who can remember what sides are? Child I, where are the sides? Can you tell me where the sides are?

**Discourse extract 11: Example of practitioner discourse at the start of a group activity**

Aspects of the procedures given at the start were repeated as the group session progresses. The language of mathematics occurred and was thereby confirmed, as is illustrated in the extract quoted above. However its occurrence was subsidiary to the practitioner’s intention of reiterating procedure. Following Wertsch’s (2002) observation that transfer of genre is occurs through teacher/pupil dyads, it would appear that these children would learn that mathematical procedures and not mathematics was the most important aspect of their lessons.

Also illustrated in the extract above are examples of formative assessment questions. Utterance analysis revealed the relatively high frequency of formative assessment of mathematics through questions to individuals in group work (Black and William, 2003). As has already been noted, the number of these questions was substantially fewer than statements about procedures. There were few general formative assessment questions (that is, questions addressed to the group as a whole) and very few formative questions about procedures. Practitioners, apart from the notable exception of Class 3/Teacher, were diligent
in asking closed questions to illicit mathematical knowledge but open questions to assess understanding were rarely asked. The answers to these closed questions were short, bringing to mind Bahktin's (1986) comment about such answers falling out of the discourse as they led to nothing. As can be seen in the example given in Appendix S, single word answers of either number or key vocabulary were more frequent than longer statements containing mathematical vocabulary.

Instruction confirming that given by the teacher in the whole class input was evident in the teaching assistant-led group work. There was more emphasis by teaching assistants on ensuring procedures were correctly followed and that the children’s learning was recorded by the end of the group work session. This was mirrored by the high frequency of oral confirmation of procedures being followed correctly compared with the low frequency of confirmation of the mathematics being correct.

There was some evidence of confirmation of cultural norms of behaviour in the form of praise and social etiquette, examples of the latter being simply ‘Please’ and ‘Thank you’. Use of praise was more frequent than utterances of social etiquette (Manke, 1997). Instances of practitioners correcting children’ behaviour were generally low. The highest frequency was towards the end of the session Nov/Class 2/gp1/TA. This was a tightly managed session with a high frequency of procedural discourse. As the children became aware of the end of the session, their behaviour became boisterous.

4.4 Total speech analysis

4.4.1 Introduction

The discussion in section 2.3 on language and lower school mathematics concluded that a supportable position would be a view of Toolan’s integrational linguistic theory qualified by the work of researchers into language and
mathematics. This position supports the inclusion of aspects of structuralist/semantic and pragmatic linguistics within the qualified view of integrational linguistic theory and not in opposition to it, thus accommodating the findings of Pimm (1995), Cobb (2000), Alexander (2004b), Mercer and Middleton (2007) and Sfard (2008). Such a position is also in accord with the qualified phenomenological ontology and epistemology presented in the Statement of Self. Toolan’s integrational linguistic theory is also qualified in that the existence of literal meaning is admitted. To restate in brief the argument presented in section 2.3, Bourdieu resonating with Vygotsky (1987) proposed the individual’s habitus and his/her socio-cultural field are indivisible and therefore exposure to language is inevitable. Pinker (1994), extending Chomsky’s (1957) position, maintained that through exposure a child acquires sufficient command of language and non-verbal communication to access this shared interaction. The logical outcome of this is that literal meaning, being a complex synthesis of the socially shared meanings of words in sentences, exists. However, in line with Toolan’s thinking, the pragmatic position that meanings associated with language are utterances interpreted in freely and endlessly variable contexts is extended to include the uniqueness of the state of mind brought to each and every linguistic exchange by speaker and listener. If this interpretation of linguistic thought is correct the outcomes of the following analysis of discourse should identify a core of literal meanings with evidence of individual interpretations dependent on context and disposition of habitus and dasein. The approach to determining this will be total speech analysis whereby extracts of speech will be considered in relation to the context and the uniqueness of the individuals engaged in speech acts. This analysis differs from the interview, word and utterance analysis in that it is purely qualitative. Approximately six hours of data was collected using video and audio recordings designed for this purpose. Analysis involved studying transcripts of speech against the background of video evidence to identify extracts that would confirm or refute the findings of the literature review and the robustness of the
Learner/Teacher Dynamic. Such an approach would also reveal insights not disclosed by the literature review.

There should also be evidence, according to pragmatic theory, of the tendency of individuals to miss out certain information because of the shared socio-cultural heritage of teachers and pupils (Bruner, 1986; Rogoff, 1990; Alexander, 2000). In section 2.3.4 it was argued the result of mathematics teachers doing this could cause confusion and the rise of misconceptions in children not having the abilities in both language and mathematics to make inferential leaps. Discussion in section 2.4.5. suggested that this would place such children would become ‘stuck’ in liminal space (Perkins, 1999; Meyer and Land, 2005), having perceived but not understood the new knowledge presented to them. If this is correct, total speech analysis would provide opportunities for the identification of children and teachers trapped in liminal space. Again, if the outcomes of reflecting upon and evaluating the literature are correct there would also be opportunities to identify evidence of instances of misunderstandings of individual words and/or utterances causing confusion and misconceptions. Total speech analysis integrates previous analysis of interview, word and utterance data within which is analysis of documentation, field notes and reflexive diary. This secondary analysis will be extended by relating the findings in this section to the theoretical model defined in section 2.7.

An interesting outcome of the utterance analysis was the identification of four registers of talk. Teacher talk, classroom talk, and social talk were all identifiable by looking at utterances. However a fourth, which has been termed ‘transitional talk’, was identified by considering longer extracts of utterances from transcripts and therefore discussion of its distinctive nature will take place as part of the total speech analysis. Also, with transitional talk, it appeared that resources played an essential part in the social construction of mathematical meaning when the
language used was neither subject specific nor focused on the task. The use of resources and the language associated with them will be a focus of section 4.4.5.

4.4.2 A core of literal meanings

The existence of a core of literal meanings identified in the word and utterance analysis was confirmed in all the observations subjected to total speech analysis, most readily in teacher/class question and answer exchanges related to the introduction or reinforcement of key vocabulary. The following example is from Nov/Class 2. The teacher had given input to her mixed Year 1 and Year 2 class to meet the learning objective ‘To recognize the properties of 2D and 3D shapes’. It should be remembered that not all teachers were as rigorous in repeating key vocabulary as was demonstrated in section 6.6:

Nov/Class 2/Teacher:  [Touches octagon displayed on interactive whiteboard, stands back, hands crossed on thigh]. Right, ready for the next one, who knows what shape this is? Child A?

Nov/Class 2/Child A:  Octagon?

Nov/Class 2/Teacher:  [Slaps thigh in acknowledgement] Fantastic! Well remembered! Octagon. Let’s say that word.

Nov/Class 2:  Octagon.

Nov/Class 2/Teacher:  Octagon. [Hand to chin, other on hip] And do you remember how we know it’s an octagon?

Nov/Class 2/Children:  [Children murmuring, thinking aloud. One says 8, but not picked up by teacher]

Nov/Class 2/Teacher:  Do you know what we spoke about? An octagon has eight sides and an octopus has eight…[Leans towards children, waggles arms like wavy legs. Finger to chin]

Nov/Class 2/Children:  Legs!

Nov/Class 2/Teacher:  Legs! That’s a really easy way to remember. Octagon sounds like…

Nov/Class 2/Children:  Octopus!

Nov/Class 2/Teacher:  Octopus! Shall we check it’s got 8 sides? Ready? [With children. Points to each side, dragging finger along each length] 1, 2, 3, 4, 5, 6, 7, 8. How many corners has it got? Take a look. How many corners? [Finger to chin. Waits for two seconds, looks at Child I. Points to corners.]

Nov/Class 2/Child I:  Eight?

Nov/Class 2/Teacher:  Good boy! It’s got eight! How many faces has it got? Child A?

Nov/Class 2/Child A:  One.
Nov/Class 2/Teacher: One, because it's a 2D shape [Leans forward, laughter and pleasure in voice]

**Discourse extract 12: Confirmation of literal meaning**

Although as can be seen strategies were adopted to represent the non-verbal communication and interaction in this total speech analysis, it was apparent that the richness of the data was lost in the process of interpretation and recording as words. Therefore video clips have been included in the appendices to illustrate the exchanges and observations upon them. The necessity of having to do so confirms Toolan's argument that attempts should be made to include context and individual disposition when analysing speech acts.

This is an example of effective building of shared language using resources, namely the image of an octagon displayed on the interactive whiteboard, children's existing mental image of an octopus, combined with kinaesthetic as well as visual and aural prompts (Wertsch, 2002). Also of note is the teacher's use of body language (Argyle, 1988; Knapp and Hall, 2006) to engage the children to emphasize key teaching points, an example of ostension, being: 'behaviour which makes manifest an intention to make something manifest' (Toolan, 1996:186). The identification of ostension is just one of the components in the complex process of socio-cognitive construction made explicit in a few seconds of interaction (see Appendix U video clip 1). Also made explicit in the recordings in Class 2 was the teacher's use of 'my' and 'our' in connection with the names of shapes, their properties and the recording of work. Not only was this an example of the strategies employed by teachers to collude with learners, noted by Manke (1997), in order to create a learning environment where the curriculum can be delivered. Additionally such use was indicative of this teacher's ostension in her intention to make manifest her empathetic and inclusive pedagogy. Despite this teacher being newly qualified (NQT) and in her probation year, she made evident a teaching style so focused on engaging the children and
enabling their learning that it was not surpassed by any other teacher observed, even the senior teacher in Class 3. The outcome of the NQT’s practice was reported by the School Improvement Partner in her report (Bedfordshire County Council 2007:2) as follows:

In mathematics … [in standards at the end of Key Stage 1] the school is very close to being 2 points above the national level…Boys slightly outperforming the girls (18.00 to 17.4). More pupils (3) achieved a L3 in mathematics, putting the school in the top quintile of LA performance.

The cohort’s scores in reading and writing were also high, but there was no comment on speaking and listening.

There were also indications of the proposition presented in sections 2.3.4 that children initially learned fragments of sentences that act as templates where words and phrases could be taken out and new vocabulary inserted as required (Pinker, 1994). The example given below is from Nov/Class 2/TA. The teaching assistant was working with the Year 1 children from the class discussed in the previous extract. She gave the children in her group plastic shapes to draw round in their books and then label:

Discourse extract 13: Sentence fragments acting as language templates

The variations on ‘got’ and ‘write it down’ are examples of fragments of sentences acting as templates where words could be taken out and/or added to as required.
(Pinker, 2004). They may also be examples of teacher talk, where children are mimicking expressions (Ben-Zvi and Sfard, 2007) used in earlier exchanges by teacher and teaching assistant. Such templates were observed in the Year 3/Year 4 class only in exchanges between the teacher and teaching assistant and the one or two children with whom they were working. These children had special education needs and therefore appeared to be at a similar stage in language development as the younger children. The older children’s exchanges were more diverse in the use of the vocabulary contained in sentence structures, suggesting they were sufficiently proficient language users not to need the support of templates.

However, difficulties in establishing shared meaning of key vocabulary because of inaccurate use of language by the teacher were also revealed. The examples above demonstrated effective use of resources to establish mental imagery (Dehaene, 1998; Wertsch, 2007) as a transition between visual/spatial objects and their symbolic representations, an outcome from discussion of the literature in section 2.5. Examples of resources being used ineffectively in establishing shared meaning were also identified. The example below was identified during the word analysis (see 4.1.2) when subjected to total speech analysis. The example was taken from the transcript of interactions in Class 1 during observation Nov/Class 1. The learning objective was to ‘learn about something called positioning’ (Appendix M p.1). There was not a lesson plan for this session.

The teacher was sitting on the carpet with the children in a semi circle around her as below. It was interesting to note the children’s neutrality in body language during the exchange (see Appendix U video clip 2). The teacher introduced words associated with position by placing slips of paper with the relevant words on the carpet in relation to her.
Figure 5: Nov/Class 1 seating plan

Nov/Class 1/Teacher: And positioning is a really big word, isn’t it? But what it means is, it’s where something is. So that I can say yo-o-o-u [Sweeping her arm from right to left] are all in front of me. This is my front. This is……where would this be? [Tapping her back]

Nov/Class 1/Child C: Back.

Nov/Class 1/Teacher: My back, behind me. And what’s this. If this is the front and this is the back, where would this be? [Patting the carpet to one side of her]

Nov/Class 1/Child C: Side. [Other children neutral]

Nov/Class 1/Teacher: Good girl! Is this at the side as well?

Nov/Class 1/Child C: [Nods. Other children neutral]

Nov/Class 1/Teacher: Yes, it is yes, so…listening…you need to be listening… Child A is sitting at the side of me. Child D, if he sits nicely, is in front of me. What's behind me? Is there anything behind me? [Turns to look behind her. Nods at Child A]

Nov/Class 1/Child A: [Glances to where the teacher had looked.] The wall.

Nov/Class 1/Teacher: Good girl! Now I thought I could have something here. [Picks up slips of paper with position words written on them.] I'm going to ask you lots and lots of words that says behind…can you remember…we'll put that behind. [Puts slip with word ‘behind’ in front of her.] Then we've got one that says in front. [Puts slip with words ‘in front’ in front of the ‘behind slip.’] One that says on top.. Where would the top be?

Nov/Class 1/Child B: I know! [Children B and C hands up. Child A, hand on head, other hand crooked at mouth.]

Nov/Class 1/Teacher: [Puts slip of paper on her head.] Could be there, couldn’t it? Like a hat, yeh, on top.

Nov/Class 1/Child C: Like you’re going to do magic.
Nov/Class 1/Teacher: [Takes slip off head and discards. Picks up another, looks at it and shows children.] It says ‘side’. If this is the back [Points to slip in front of her] and this is the front [Points to slip in front of ‘back’ slip], where would I put the side, Child B?

Nov/Class 1/Child B: Mmmmm.

Nov/Class 1/Teacher: [Pointing in turn.] Shall I put it there [‘behind’ slip], there [‘in front’ slip] or there [To the left of the ‘in front’ slip]?

Nov/Class 1/Child B: There! [Points to the correct slip].

Discourse extract 14: Difficulties with the language of position

Until this last utterance by Child B, only Child C had answered questions to do with ‘back’, ‘behind’, ‘in front’ and ‘side’. This child was in a position relative to the teacher where the words had their understood meaning. However ‘back’ was in fact ‘in front’ of her. To understand this, she had to decentralise, in Piagetian terms, and see the slips on which the key words were written from the position of the teacher. Likewise, Child B had to do the same to give the correct answer to the slip on which ‘side’ was written as it was actually in front of her. Child A gave the correct answer to the teacher’s ‘is anything behind me?’ by following a non-verbal cue. Because she did not respond to any of the other questions, it appears she could not decentralise. Three children took no part in the exchanges. Here there is evidence for Donaldson’s (1978) refutation of Piaget’s belief that decentralization is age-related.

The teacher then introduced a teddy and a box. The box was positioned between her and the children. The same procedure was followed with children being asked to position the teddy bear. The words ‘top’, ‘over’ and ‘round’ were introduced. All the children could correctly answer questions concerning these positions. However at the end of the session the following interaction took place.

The positions of the teacher, children and box were as follows:
Figure 6: Nov/Class 1 seating plan with box

Nov/Class 1/Teacher: Child C, could you put the teddy bear at the side of the box?
Nov/Class 1/Child C: [Picks up teddy bear and looks at teacher]
Nov/Class 1/Teacher: At the side, at the side!
Nov/Class 1/Child C: [Points over the box towards Child F]
Nov/Class 1/Child D: [Shakes his head.] No!
Nov/Class 1/Teacher: [Frowns at Child D]
Nov/Class 1/Child C: [Puts the teddy bear at position X in Figure 6. She smiles.]
Nov/Class 1/Teacher: She's right!
Nov/Class 1/Children: No!
Nov/Class 1/Teacher: I think she is! Put your hands up if you think she's put the teddy bear at the side of the box.
Nov/Class 1/Children: [Children B, E and F raise hands. Then Child C raises her hand tentatively]
Nov/Class 1/Teacher: See you're all saying no but you're all agreeing with me! What are you like! Today, I think you did very well with that.

Discourse extract 15: Example of confusion due to mismatch of resource and language

The body language in this exchange was informative (see Appendix U video clip 2). Even Child C, who demonstrated in the earlier exchange that she could decentralise and understood ‘side’, was no longer sure. The teacher’s praise at the end must have increased feelings of confusion as the children knew that they did not understand. Wells and Montgomery (1981) and van Dijk (1993) suggest
that the children could now be tempted to construct meaning that could be incorrect or incomplete. The children’s raising of hands confirms Fisher’s (1993) observation that such exchanges will result in children indicating what they think the teacher wants to hear and not to show their understanding. All, apart from Child B, appear to be ‘stuck’ in liminal spaces (Meyer and Land, 2006). They could not connect the words of position, which were not new to them, with the example of their use as presented by the teacher in the lesson. It is suggested that understanding of position in relation to oneself is to do with the literal meaning of the words used, whereas understanding of position in relation to other objects is a threshold concept. As Meyer and Land (2005) maintain, such insights transform an individual’s understanding of the subject area and also of the world view. They also maintain that extension of specific language is an essential part of threshold concept theory. In this case, extension is not in terms of additional subject specific vocabulary but within the meanings of familiar positional words.

Other interesting insights from the exchanges above are that the use of resources does not automatically invoke clarity and that children’s responses to a teacher’s non-verbal cues may result in faulty formative assessment (see section 2.5).

An interesting speech event occurred in this session to demonstrate Bourdieu’s (1990) concepts of habitus and field, and Toolan’s (1996) belief that each person should be regarded as individual and that no aspect of their behaviour or personality should be taken for granted:

Nov/Class 1/Teacher: What room’s this?
Nov/Class 1/Child A: It’s the kitchen. There’s a table in there an’ all.
Nov/Class 1/Teacher: There is a table. [She turns to look at Child F and smile] Have you got a table in your kitchen at home?
Nov/Class 1/Child F: [F in front of the doll’s house looking, hands together] Have you?
Nov/Class 1/Child A: Yeeeeess!!
Nov/Class 1/Teacher: [A taps Child F’s arm]
Nov/Class 1/Child A: I’ve got a big table in my house. I’ve got, I’ve got….
Nov/Class 1/Child F: [Looks down, shrugs]
Nov/Class 1/Teacher: [To Child F] And where’s your table. Have you got a table at home. Some people don’t have tables at home, you see.
Nov/Class 1/Child F: [Waving hands in front of her, disturbed] We’ve got a small table in front of our TV. No mummy and daddy…um…um no children, and I just sit there and eat by myself looking at TV.
Nov/Class 1/Teacher: That’s a little bit sad, isn’t it? It makes me feel a little bit sad. Really. Now what are we going to put inside our house?

Discourse extract 16: The necessity for shared experiences

Shared meanings have to be built on shared experiences (Vygotsky, 1986 trans.; Mercer, 2000; Mercer and Middleton, 2007)). The difference in meaning of ‘table’ and the emotional connotations associated with the word for Child F prevented her from engaging with the locative terms of mathematics (Toolan, 1996). The exchange is also interesting in that the asymmetrical nature of most practitioner discourse has been suspended here. There is still discernable IRF (Sinclair and Coultard, 1975) but Child F’s contribution is similar in extent to the practitioner’s. The practitioner has been successful in encouraging Child F to talk, to use language in dialogic interaction (Mercer and Littleton, 2007). However control of the power relations is still with the practitioner (Thornborrow, 2002). The last sentence demonstrates that she regards her response as being correct, that is, that Child F should be ‘a little sad’ too. Child F’s body language does not suggest that she considers eating whilst watching TV to be a negative experience.

Also the lack of symmetry provides insight into Foucault’s (1980) conceptualization of power as a multifaceted and constantly developing web of social and discursive interactions. The relations between practitioner and children were asymmetrical and the power differentiation greater during the whole class input part of the lesson. In all of the observations some degree of change in the
power relations between practitioner and children can be seen. The greatest asymmetry was evident during the teacher-led whole class inputs and the least between peers during unsupervised work. This has implications for the Learner/Teacher Dynamic as will be discussed during the remainder of this section on total speech analysis.

4.4.3 Missing out information

The following is an extract from the teacher’s input during Nov/Class 3, the mixed Year 3/Year 4 class. The learning objective was to revise the knowledge of multiplying and dividing. The session began with a mental/oral starter on doubling and halving at which the children were successful. The teacher then attempted briefly to show the relationship between multiplication and division before progressing to introduce the recorded work (Appendix U video clip 4) which involved writing down repeated additions as multiplication sentences:

Nov/Class 3/Teacher: Now can anybody remember what I asked the question for? I asked someone to double 14 didn’t I. OK and the answer was… What was the answer to double 14?

Nov/Class 3/Child B: Twenny-eight.

Nov/Class 3/Teacher: [ Writes 28 on the whiteboard] 28 and I just asked somebody to halve the number [Pause] so I’ve got 28 and I’ve asked people to halve that (Pause) and what we’ve actually got done is to go and write that down to 14. OK? [Writes 14 on the whiteboard] That’s what actually happened there. We’ve actually gone right back down to the number 14. OK, so now I want you to listen to what we are going to do this morning so we’ve halved the number and doubled and it’s going to be quite important, OK, when you think about the work you are going to be doing this morning. Halving and doubling. [Writes ‘double’ on the whiteboard] Now. Let me see, we’re going to write, I’m going to put a symbol on the board [ Writes ‘X’ on the whiteboard in a clear space away from the numbers 14 and 28] now and I want you to tell me what would you do to, with the numbers if you saw this symbol? What would you have to do to the numbers that are at either side? OK, what would you do?

Nov/Class 3/Child B: Double it?

Nov/Class 3/Teacher: Almost! I can see where you’ve got the connection! Well done!
Discourse extract 17: Missing out vital information and its effect on learning

The tone of the teacher’s voice to Child B was confirming, at variance with her obvious indication to Child G that he, not Child B, had given the correct answer. This practice, observed in Nov/Class 1, could have resulted in confusion (Wells and Montgomery, 1981; van Dijk, 1993, Ben-Yehuda et al., 2005). Doubling can be used in multiplication as repeated addition but only in simple examples where the multiplier is two, and four. Otherwise further steps are necessary, for example $3 \times 8 = \text{double eight plus eight}$, or double eight doubled again minus eight. The teacher did not include exposition on this, resulting in confusion and a misconception that doubling and multiplication as repeated addition are equivalent in some way. It can be seen that the teacher was in liminal space (Meyer and Land, 2006). She clearly does not have sufficient understanding of the relationship between doubling and multiplication as repeated addition. There was no evidence from the video at this point that the children had inherited her confusion and were in their own liminal spaces. As this was a lesson of reinforcement, the children had gained the threshold of the concept that multiplication is repeated addition and could no longer go back to a state of not knowing the concept existed. So they had either passed through the threshold or remained in liminal space. Indication that some of the children were stuck in liminal space was revealed later in the same lesson when the teacher moved on to revise multiplication as repeated addition and then to revise division as repeated subtraction (Appendix U video clip 5):

Nov/Class 3/Teacher: OK. So that’s what we’re going to do today. Use of repeated addition and repeated subtraction, OK and to understand what the connection is between those two, OK, between multiplying and dividing. Right, what does this symbol mean?
[Writes division sign on board]. More important for groups 1 and 2. If you see that symbol, what does it mean? It’s bit strange looking, but what does it mean, OK? Child E?

Nov/Class 3/Child E: Divide the numbers either side.
Nov/Class 3/Teacher: It means you divide the numbers either side. Good girl. OK? To divide the numbers either side. How can we divide numbers? Give me some other words we’d use for divide? What you actually do when you do the activity? If you’re dividing. [Silence]. OK, let’s do it another way. Let’s go back to our multiplying. What about multiplication then? What are you actually doing when you are multiplying? Ooh. Hands up, Child D!

Nov/Class 3/Child D: Adding!
Nov/Class 3/Teacher: Good answer! Hand up! Well done. Multiplying is like you are adding the number. It is connected to doubling the number almost. So adding, you’re adding the number each time. So what does it make you do when you are multiplying, when you are adding those numbers…

Nov/Class 3/Child C: You get a bigger number?
Nov/Class 3/Teacher: You do get a bigger number but…
Nov/Class 3/Child C: Making the number bigger by adding the same?
Nov/Class 3/Teacher: Almost but you’re adding the numbers each time aren’t you and you’re grouping the numbers [Writes grouping on the whiteboard]. Give me another example of multiplying. So we group the numbers …what else?

Nov/Class 3/Child C: Doubling?
Nov/Class 3/Teacher: Doubling the numbers. OK, give me an example of dividing then, [Writes ‘dividing’ on the whiteboard] if you’re dividing something, what are we doing?

Nov/Class 3/Child E: Halving
Nov/Class 3/Teacher: We’re halving [Writes ‘halving’ on the whiteboard]. Good. What else are we doing? If I have…OK, then, I have a piece of cake, yum-yum [Draws circle in the air in front of her], and I have three people here, what do I need to do with that piece of cake?

Nov/Class 3/Child D: Halve it!
Nov/Class 3/Child C: Share it!
Nov/Class 3/Child D: Double it!
Nov/Class 3/Teacher: Share it! So sharing is also part of dividing. When you divide something you’re sharing it, you’re grouping it, you’re putting it together so it’s easier to look at, OK?

Discourse extract 18: Example of teacher being ‘stuck’ in liminal space

The teacher clearly did not have sufficient understanding of either of the relationship between multiplication and division or the language to clearly and
precisely express it. She was in liminal space. What is more her exposition placed some of the children in liminal space as well (Ben-Yehuda et al., 2005; Meyer and Land, 2006). This was demonstrated by the recording of the following exchange in the most able group between the two best mathematicians in the class:

Nov/Class 3/Child F: I don’t get it! I don’t get it!
Nov/Class 3/Child G: What did you get to, number 3?
Nov/Class 3/Child F: I only got up to 2, I don’t get it.

**Discourse extract 19: Children expressing confusion resulting from their teacher’s discourse**

These discourses confirm the proposition put forward in Table 1 and section 2.5.3, namely that area most likely to produce misconceptions in mathematics is the transitional area between the real, external three-dimensional world and the abstract, internal world of thought mediated by language and its symbols because of the potential to misinterpret resource and language. It was suggested that this area could be related to liminal space in threshold concept theory because here learners will become ‘stuck’ (see section 2.4.5). These discourses demonstrate that the children were clearly having difficulty with translating the information presented to them in the three-dimensional real world of the mathematics lesson. To answer the questions put to them, they had to foreground their current conceptions of multiplication and link them to the two-dimensional world of written mathematical language presented by the teacher using the resources of whiteboard and Unifix, and mediated by the spoken and non-verbal mathematical language used by the teacher (Wertsch, 2002). Two of the most able children mathematically externalised their difficulties. It can be assumed that other, less able children, were in liminal space but kept their thoughts to themselves.
4.4.4 Teacher talk and children’s abilities to construct understanding

Children’s abilities to construct mathematical skills and understanding from teaching locked in liminal space were identified in March/Class 3. Both groups were given similar tasks but very different input by the teacher. An extract is given below that demonstrates how the ‘average’ children in group 2, by initiating a dialogue with the teacher around a resource, built meaning from their own mathematical ability and prior knowledge, and using each other as scaffolds (Bruner, 1986; Vygotsky, 1986 trans.; Ben-Zvi and Sfard, 2007). A second extract is given to demonstrate how the children in group 1, the more able group, failed to achieve understanding because they did not push the teacher to give examples. The result was that the more able group 1 produced work showing a greater number of errors than the ‘average’ group 2. The terms ‘more able’ and ‘average’ were given to the groups by the teacher. It must be remembered that there were only nine Year 4 children in the class and all were contained in these two groups. So the descriptions ‘more able’ and ‘average’ as assigned to these two groups might not be accurate as no less able children were identified by the teacher.

The learning intention was to sort numbers in a Venn diagram. The children were enthusiastic and had already worked with Venn diagrams so the first task was completed quickly, group 1 completing first. Both groups’ work contained mistakes but the teacher did not check the work before going on the second activity. This involved taking the numbers from the first activity and sorting them on a Carroll diagram. The teacher worked with the groups separately. She advised the children in group 1, but not group 2, that they had worked on Carroll diagrams before. Group 1’s first activity had been to sort numbers in the 5X and 10X table into the three areas of a Venn diagram. It is clear these would not easily sort into a Carroll diagram. The teacher’s explanation began with reference to sorting shapes into a Carroll Diagram. Although the teacher reminded the
children that they had met a Carroll Diagram before and that she felt sorting shapes into its various areas would be too easy for the group, the children’s body language demonstrated lack of conviction (see Appendix U video clip 6). One child, Child A, tried to relate the previous activity to what his teacher now wanted him to do:

March/Class 3/Teacher: OK, you’re going to use the numbers here, and I want you to think of a way of sorting, in pairs, sorting the numbers that you have so that they all fit in here [Indicating the Carroll diagram drawn on the small whiteboard], somewhere on the chart.

March/Class 3/gp1/Child A: So it’s the 5X table and the 10X table.

March/Class 3/Teacher: Thank you very much! So someone’s thinking through. Imagine if these are your numbers. These numbers have got to go somewhere on your chart. What did you say, Child A, what to do?

March/Class 3/gp1/Child A: You put 5X table and 10X table on the top and not 5X and 10X down the side.

March/Class 3/Teacher: You think that’s an easy one. What else could you do? Look at the numbers, what else could you do? What else could you do? I’m going to leave you here. I don’t mind what you do about that one, but I really want you to think about what you are doing. That is a fabulous one to do but look at the kind of numbers that you have and think of a way of working it out, OK? Have a go! I just want you to have a go, OK?

**Discourse extract 20: Non verbal communication**

Child A was following the teacher’s words logically but the example given will not work in Carroll diagram format. The children’s body language shows indecision and confusion. Heads are down. Child D looks into the distance. Child A and Child C are resting their heads in their hands as they look at their worksheet. Child A and Child C completed the task as best they could and then put their hands up to show that they had finished. As the teacher had realized that the other children in the group had not understood, she then asked Child A and Child C to show them how to complete the task. She did not check Child A and Child C’s work. The result was that, as their written work demonstrates, all children
completed the task incorrectly though the children did not know that because their worksheets were given to the researcher unmarked at the end of the lesson (Appendix T). However, the children’s body language on completion of their task suggested that they were pleased that their work was finished.

Group 2’s first activity had been to sort a set of given numbers into a Venn diagram according to the criteria of numbers with 3 tens and even numbers. The children’s worksheets demonstrate that Child D completed it correctly. Child H did not complete but what she did was correct. Child I did not fully understand and Child G’s worksheet was not given to the author. Again the teacher did not look at the worksheets before introducing the Carroll diagram task as follows (see Appendix U video clip 7):

March/Class 3/Teacher: I want you to look at your numbers, your numbers on there, OK? [Indicates the worksheet] This is another way of sorting your numbers, the numbers on the bottom of your sheet. OK, those numbers there. Are we, look at those numbers and think how they could go into a Carroll diagram and I’ll come back.

March/Class 3/gp2/Child D: What?
March/Class 3/gp2/Child I: I don’t know.
March/Class 3/Teacher: Right, OK, ready. I’ll explain [Puts small whiteboard vertically on group’s desk]. Let me explain to you. You’re going to put the numbers, this is a different way of sorting numbers, OK, a Carroll diagram, so in here [Pointing to Carroll diagram] you’ve got all these numbers, you’ve got 66, 4 [Writing on the whiteboard], I'm not going to write them all because I haven’t got all day, this is a different way of recording information. So for example you could put in here numbers bigger than 10, for example, or numbers bigger than 30, and they go in there, alright [Writes ‘numbers bigger than 30’ at X] Here [Pointing to Y] you could have numbers without a, um, can’t have, um, one of you [sic]. So you look at your numbers there and there might be, like 31, so that’s a number ending with a 30 but because it’s got a number one at the end you can’t put it in there [Points to XY] so you put it in here [Points to XZ].

March/Class 3/gp2/Child D: So if you’ve got 31, and because it’s bigger than 30, you have to put it there [Points to XZ], and if
it’s smaller than 30 you have to put it there [Points to *].

Discourse extract 21: Constructing understanding

<table>
<thead>
<tr>
<th>X</th>
</tr>
</thead>
<tbody>
<tr>
<td>Y</td>
</tr>
<tr>
<td>Z</td>
</tr>
<tr>
<td>XY</td>
</tr>
<tr>
<td>XZ</td>
</tr>
</tbody>
</table>
* |

Table 6: Venn diagram drawn by March/Class 3/Teacher for Group 2

Child D and Child I are animated and appear to enjoy working out what they are meant to be doing with the teacher. The remaining two children simply watch, appearing to be waiting to be told what to do so that they can complete the task. The desire to complete the task as a sign of success was noted in all the observations. Discourse subsequent to the transcript above between the group members whilst the teacher watches silently is indistinct in places but the interaction can be seen in the video clip. It appears that, after trying out a few numbers, the group work individually on their Carroll diagrams. Child D and Child H were successful without errors and Child I successful with errors (see Appendix T). Whilst the Carroll diagrams were being constructed there was little discourse discernible but the children’s written work demonstrated their understanding. This was accomplished by a shift in the balance of power relations. This extract illustrates Foucault’s conception of power as existing in a complex and shifting web of social relationships and actions at local level. Instead of accepting the teacher’s explanation, Child D questioned it or, as in Foucauldian terms, resisted it ‘right at the point where power is exercised’. In addition the discourse above shows how the group, led by Child D, were able to see through the misuse of language by referring to the Carroll diagram and through collaboration (Vygotsky, 1986 trans.). It is most unfortunate that the audio device on this table did not
record effectively as the precise analysis of the language used in the children’s structuring of their understanding would have been informative.

The mid-Key Stage SATs results for the Year 4 children have already been discussed in relation to the Class 3 teacher’s pronounced use of everyday words. An explanation might be that mathematically more able children can extract the correct, precise mathematical meaning of a lexical and everyday word and apply it consistently in a mathematical context (see section 2.3.4). However, no instances have been observed of children using lexical or everyday words inappropriately in a mathematics lesson. Some of the Reception children made mistakes with language but this was in the process of attaching the correct word to its literal meaning. A more persuasive argument would be that more able children are able to construct meaning from a combination of prior experience, language and resources applied to the current tasks. This would confirm Cobb’s (2000) insight that learning mathematics involves symbolising, communicating and mathematising and Wertsch’s (2007) perceptions on mediation through language and resources. The video clips and discourse extracts form the two observations in Class 3 clearly evidence children through collaboration, using language that comes naturally for them (attempting to piece together fragments of knowledge to make mathematical sense despite the confusing messages they were receiving from their teacher (Ben-Yehuda et al., 2005). It would appear that being able to talk with peers might have greater impact on children constructing knowledge as the children in Class 3/Group 2 were deemed to be ‘average’ (Mercer and Middleton, 2007). The children’s mid-Key Stage SATs scores confirm this as Child D, the instigator of the exchange with the teacher, received a 3B and the other children a 3A, a 3B and a 3C. The average grade attached to this test by national guidelines is 3B.
The teacher in Class 3, as has been noted in previous discussion, was a not secure in her mathematical subject knowledge and pedagogy yet her class achieved results that placed the school above the Local Authority average and in line with national expectations (see Appendix Q, School Improvement Partner Data Review Visit, Autumn 2007 and Visit Report 1B). Although no grades or percentages were available in speaking and listening, the Visit Report 1B states in relation to Year 4 ‘In reading the school is significantly above the national expectation levels’ and ‘standards achieved are… above [national expectations] in writing’. This indicates support for the proposition that language skills could be important in mathematical achievement and does not undermine the position that mathematics relies on non-specific, natural language for children in lower schools.

4.4.5 Two new registers

Utterance analysis of the discourse in Nov/Class 2 revealed the possibility of a new register situated between classroom talk and social talk. The identification of the first new register, termed ‘transitional talk’, suggested the existence of a hierarchy embedded in Foucault’s (1980) conceptualization of power as a multifaceted and constantly developing web of social and discursive interactions and defined by the degree of practitioner control evident in the discourse. Teacher talk would be the most formal talk in the hierarchy, social talk the least formal. This was reinforced by the identification of a second new register, that of conditioned talk. A description of the hierarchy is given by the descriptions of the various types of talk identified during the course of analysis. Teacher talk has been defined as children’s discourse controlled by the teacher and is most clearly seen during the teacher input to class lessons. It has a ritual quality in that it takes the form of question or statement and response with the teacher, rarely the children, asking the questions. Classroom talk is children’s discourse emanating from the practitioners’ control and is related to utterance forms evident in the practitioners’ classroom discourse and takes place during group sessions led by
teacher or teaching assistant. Conditioned talk takes place during unsupervised sessions. In this register children are focused on their work. They used subject specific, lexical and everyday language to work out mathematical problems, inform their peers, share findings and reinforce each other’s learning. These were all units of meaning identified in interviewees’ responses as being purposes for peer-peer language (see section 4.1.1.3 and Appendix K Chart 6). Conditioned talk was observed briefly in Nov/Class 2/gp2 and in more lengthy extracts in Nov/Class 3/gp1 and Nov/Class 3/gp2. Conditioned talk was more prevalent during the March observations, being observed in Class 2/gp 3 and in Group 1, 2 and 3 in Class 3. The ability to engage with conditioned talk appeared to develop with age.

Transitional talk was observed only taking place during unsupervised sessions. It appeared that this talk was different to both classroom and social talk because it included mathematical words and therefore could be construed as being focused on the task. This suggested there could be a transitional register that was based on social talk whilst giving space for thoughts to form on the mathematics task. Observations of the other sessions were scrutinised for repetition of this register which can be termed ‘transitional talk’, but none was found. The language used in transitional talk was less focused on the mathematical or procedural language evident in the practitioner-led discourse and more on the underlying social relationships. Social talk was talk unconnected with the task of learning, either of mathematics or the procedures associated with it. This talk was most evident during unsupervised activities though short extracts were identified during practitioner led activities in all classes observed.

Teacher talk was illustrated during previous discussion by examples to be found in section 4.2.2.7. To exemplify the difference between classroom talk, directed talk, transitional talk and social talk two extracts from Nov/Class 2 and two
extracts from Nov/Class 3 are given below. The first, comprising classroom talk, involved Nov/Class 2/gp 1 in which a teaching assistant worked with her group of Year 1 children on identifying attributes of 2D shapes. The second, exemplifying conditioned talk, was observed in Nov/Class 3/gp 1, Year 4 children who were working on multiplication as repeated addition. The third extract involving transitional talk was observed in Nov/Class 2/gp3, the children in which were all Year 2 children. The group was tasked with placing illustrations of 3D shapes in a Venn diagram. The fourth example, of social talk, was also from Nov/Class 2/gp 3 and occurred several minutes after their transitional talk.

Classroom talk

Nov/Class 2/gp1/TA: Ah, that’s a good boy, C. How many sides have you got, B?
Nov/Class 2/gp1/Ch B: 4.
Nov/Class 2/gp1/TA: Right then, write down 4. How many sides has yours got?
Nov/Class 2/gp1/Ch B: 4.
Nov/Class 2/gp1/TA: Write down 4 then.
Nov/Class 2/gp1/Ch C: Look, do you have to do it like that?
Nov/Class 2/gp1/TA: You could do it, if you’ve got a triangle, you could always do an arrow and a number like that [Writing on a small whiteboard].
Nov/Class 2/gp1/Ch C: 4 corners.
Nov/Class 2/gp1/TA: You could do it like that.
Nov/Class 2/gp1/Ch C: And circle?
Nov/Class 2/gp1/TA: What are you writing, B? You do that there. Just draw an arrow to one of the sides. You can do it like that. See? OK, has everybody written down how many sides it has?
Nov/Class 2/gp1: Yes!
Nov/Class 2/gp1/TA: Now we’re going to write down how many faces it has, how many faces….
Nov/Class 2/gp1/Ch A: It’s got 1.
Nov/Class 2/gp1/TA: If it’s got 1 write it down in the middle.
Nov/Class 2/gp1/Ch A: 1 in the middle.
Nov/Class 2/gp1/TA: It’s got 4 sides, like that you see.

Discourse extract 22: Classroom talk

Classroom talk is children’s discourse emanating from the practitioners’ control and is related to utterance forms evident in the practitioners’ classroom discourse. The children’s contribution to discourse is greater than during teacher
talk. The practitioner-led input discourse was characterised by IRF (Sinclair and Coultard, 1975), question and answer interspersed with some instruction and explanation. The power differential between practitioner and child was explicit and non-negotiable. Discourse was centred on the activity and understanding of the subject embedded in classroom talk, not on the relationships and understandings arising out of a shared cultural and social background.

**Conditioned talk**

<table>
<thead>
<tr>
<th>Nov/Class 3/gp1/Ch C:</th>
<th>9+9+9+9+9 [Voice denoting boredom].</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nov/Class 3/gp1/Ch B:</td>
<td>I can’t believe it!</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch E:</td>
<td>I need a rubber.</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch B:</td>
<td>You won’t find one here.</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch A:</td>
<td>1, 2, 3, 4, 5, 6, 7. [Picks up a number line].</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch E:</td>
<td>Now I haven’t got a pencil.</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch C:</td>
<td>9 +9+9+9+9+9.</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch A:</td>
<td>No, it’s 1, 2, 3, 4, 5, 6, 7 nines.</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch C:</td>
<td>7 nines?</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch F:</td>
<td>Hey, you made me lose count!</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch A:</td>
<td>I only have to do three more!</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch D:</td>
<td>42.</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch A:</td>
<td>[Looks at Child D's work] That was the right answer as well!</td>
</tr>
<tr>
<td>Nov/Class 3/gp1/Ch E:</td>
<td>I know.</td>
</tr>
</tbody>
</table>

**Discourse extract 23: Conditioned talk**

In this example of conditioned talk, the children were focused on their work in the same way as when supervised by teacher or teaching assistant. However, the control of the teacher had been given to the children. Their language expressed their desire to complete their work. It was more extensive than when supervised. They used mathematical language but interspersed it with natural language that reflected their relationships with each other. They worked out problems together, informed their peers, shared findings and reinforced each other’s learning. The language use shows aspects of structuralist, pragmatic and integrational linguistics. Having ownership of the learning experience and working collaboratively using language, resources and peer assessment, these children
were working effectively as a group. Other observations of conditioned talk confirmed these positive traits.

Transitional talk

Nov/Class 2/gp3/Ch A: It says curved sides.
Nov/Class 2/gp3/Ch B: It goes in the middle.
Nov/Class 2/gp3/Ch A: Child C?
Nov/Class 2/gp3/Ch C: No, I won’t be your friend!
Nov/Class 2/gp3/Ch B: Hey you’ve got the magic (indistinct)!
Nov/Class 2/gp3/Ch B: I’m next!
Nov/Class 2/gp3/Ch A: Yep!
Nov/Class 2/gp3/Ch B: My turn.
Nov/Class 2/gp3/Ch A: No!
Nov/Class 2/gp3/Ch C: Yep!
Nov/Class 2/gp3/Ch A: She’s cutting the tip off!
Nov/Class 2/gp3/Ch C: He’s doing that one.
Nov/Class 2/gp3/Ch A: That goes in that one, you now.
Nov/Class 2/gp3/Ch C: It doesn’t!
Nov/Class 2/gp3/Ch A: It does!
Nov/Class 2/gp3/Ch B: I’ll put it in the middle.
Nov/Class 2/gp3/Ch A: Silly dum-dum!
Nov/Class 2/gp3/Ch B: Hey!
Nov/Class 2/gp3/Ch C: You put it in the wrong way!
Nov/Class 2/gp3/Ch A: Doesn’t thingy go in the middle?
Nov/Class 2/gp3/Ch C: Shape! Shape!
Nov/Class 2/gp3/Ch B: It goes in the curved sides.
Nov/Class 2/gp3/Ch A: Now it’s Child C’s go.

Discourse extract 24: Transitional talk

The language used in here was less focused on the task than in the example of directed talk above. Control was still with the children but they were not using it as their teacher would have wished. Despite coming from different villages the children in this group had sufficient shared social and cultural understanding to engage in discourse that would be only partly intelligible to an outsider having access only to the aural transcripts. Their focus was on their work but their concentration had dissipated. There was still a degree of working out problems together, informing their peers, sharing findings and reinforcing each other’s learning. However, the emphasis of their language was less on that of learning and more on the underlying social relationships.
Nov/Class 2/gp3/Child B in the extract above was the only boy. The group’s task was to cut out drawings of 2D and 3D shapes and sort them according to the descriptions on a Venn diagram. In the extract exemplifying transitional talk the boy’s contribution to the discourse was firmly focused on the task in hand. The other children in the group, three girls, were not so directly engaged. They were dominated by the personality of Non/Class 2/gp3/Child A, the most immature of the group. Toolan’s (1996) perception that the totality of an individual, what Bourdieu (1990) would term habitus, is involved in speech acts and their perlocutionary effect is demonstrated here.

Nov/Class 2/gp3/Child B tried to remain on task and attempted to involve the girls with utterances about taking turns and comments on the task. The girls’ discourse was not as structured and there was little in their words and syntax to assist the hearer in understanding their meaning. However all contributions to the discourse were free-flowing and spoken without hesitation. It appeared that the girls clearly understood the direction and meaning of their discourse and were engaging with the activity, though it is clear from the video evidence that they did not completely understand what they were doing. Released from practitioner control, explicitly as in classroom talk and implicitly as in conditioned talk, of the utterance forms related to the practitioners’ classroom discourse, the girls naturally changed their discourse to cement their relationships and in doing so excluded the boy. The distinguishing feature of transitional talk is the confirmation of social peer relationships in non-directed activity whilst engaged superficially on a teacher-initiated task. Transitional talk also serves to support peer relationships by bringing their natural register of talk used in playtimes and out of school interactions into the classroom. Children spend more time out of the classroom than in it, so reverting to social talk around the teacher-initiated task in the classroom when possible would be a natural act.
Social talk

Nov/Class 2/gp 3/Ch A: [Singing] Na-na-na-ner-na!
Nov/Class 2/gp 3/Ch A: Let’s all sing ‘I wish I was a pop star!’
Nov/Class 2/gp 3/Ch B: My turn.
Nov/Class 2/gp 3/Ch D: I’m not singing! Can you hear me not singing?
Nov/Class 2/gp 3/Ch B: I’m doing the hardest one.
Nov/Class 2/gp 3/Ch A: Look what I’m doing [Mimes a dance].
Nov/Class 2/gp 3/Ch C: That’s Shakira.
Nov/Class 2/gp 3/Ch A: I’ve got my own CD of Shakira and it says it’s a Spanish one. It says it’s a Spanish one. It’s got lots of songs. I don’t know ‘em so I’ve got to learn ‘em [Giggles].
Nov/Class 2/gp 3/Ch D: I’m learning this song, um…
Nov/Class 2/gp 3/Ch A: Oy! Let’s sing…
Nov/Class 2/gp 3/Ch A: My mum says I need a haircut.

Discourse extract 25: Social talk

In this example the focus on the task had complexly evaporated. The emphasis was on social relationships and out-of-school experiences. The discourse was similar to that to be heard in the playground (Opie, 1993; Grugeon, 2005).

This discourse was available on the video recordings. However, the separate audio recordings enabled the difference in register to be identified whilst maintaining a sense of the totality of the learning context, thus maintaining a balance between the general and specific. By contrast word and utterance analysis did not require such an approach, although however utterance analysis provided the first evidence of transitional talk. Nevertheless analysis of transitional as utterance type would have detracted from its distinctive quality of spontaneity related to context and comparative status. Until the total speech analysis was undertaken, conditioned talk had been considered as being classroom talk as lack of supervision in directed talk had not been identified. This confirms an outcome from the literature review, that structuralist and semantic, pragmatic and total speech approaches to linguistics all have their part to play in providing insights into the complexities of discourse.
4.4.6 Group work

Another aspect of interest revealed by utterance analysis and confirmed by total speech analysis was the children’s developmental understanding of the meaning of the words ‘group work’. Discourse in groups was associated with the dominant procedural intention identified though utterance analysis (Alexander, 2004b). For example the Year 2 children in Class 1 understood the difference between ‘group work’ meaning working in a group and ‘group work’ meaning working as group.

For example when Nov/Teacher/Class 2 had explained the task, mentioned four names and finished by saying ‘You’ll be working in a group on that table,’ the four children went to the table indicated with no further conversation. However they appeared to think that working as a group meant taking turns. There was discussion about the task and what was required, namely cutting out 2D and 3D shapes. The children organised themselves into an order and proceeded to cut and stick the shapes in the appropriate place on a Venn diagram. The children’s understanding of working as a group was associated with kinaesthetic activity, for example, the cutting out of a shape or sticking it on a worksheet. There was no discussion on whether the position on the Venn diagram was the correct one beforehand. Nov/Class 2/gp3/Child B commented after the event on several occasions that the position assigned to a shape by one of the girls was incorrect but he did not appear to have the language to explain. One instance of this is as follows:

Nov/Class 2/gp3/Child B I’m going to do the square.
Nov/Class 2/gp3/Child C Wait! Wait!
Nov/Class 2/gp3/Child D Where does that one go?
Nov/Class 2/gp3/Child B No, it doesn’t go in there!
Nov/Class 2/gp3/Child C It goes in there.
Nov/Class 2/gp3/Child B No.
Nov/Class 2/gp3/Child C Why?

Discourse extract 26: A child’s lack of language to explain
This has implications for the application of socio-cognitive theory (Vygotsky, 1986 trans.) to pedagogy. It would appear that children’s capability of working together independently on a task to produce a joint outcome, using language and resources to construct shared understanding, has to be taught and developed. As well as appropriate social skills, the extract above suggests that children have to have sufficient mathematical language before they engage in the task to learn and to assist in the learning of others socio-cognitively.

Whether the girls understood what they were meant to do is not evident. The illustrations of the shapes on the worksheet were poorly drawn and the task itself not clearly focused. This suggests that resources can cause problems in the transition between the real visual/spatial three-dimensional world and the two-dimensional worlds of symbols (see Table 1, sections 2.5.3 and 4.4.3). Eventually the Venn diagram was completed with the support of the teacher in the last minutes of the session. The discourse suggests that Nov/Class 2/gp 3/Child B understood what he had to do but the girls did not. As the discourse from this group given above demonstrated it appears that their resulting lack of engagement prevented the group and Nov/Class 2/gp 3/Child B in particular from completing the task. There appears to be a gender issue here. As discussed above this group’s descent into transitional then social talk resulted in the girls coalescing into their gender group, excluding the boy. This suggests that careful thought has to be given to the membership of groups, although it is acknowledged that the small cohort in Year 2 provided limited choice and could have been contributory to this issue.

However it does appear from the extract above that Nov/Class 2/ Gp 3/Child B understood the mathematics but did not have the language to express his understanding. His grade of 3C in the Key Stage 1 SATs held in May 2007 following the recorded observations confirmed his ability. He was the one child in
the group who did appear to have understanding. As he could not explain after the event it can be reasonably assumed that he would not have been able to explain before the event, even if he had the visual representation in his mind of the shape in its allotted place on the Venn diagram. This suggests that understanding of mathematical concepts does not depend on language by itself. It also suggests that appropriate resources are essential in that they enable children to demonstrate their understanding before the language of that understanding has been mastered (Wertsch 2002). Resources were clearly regarded by the teachers as being important in all the whole class inputs and supervised group work sessions observed despite their low profile identified in the interview data (see section 4.1.1.3). In these interactions resources were intended to be used in an integrated and focused multisensory approach to teaching. However in this unsupervised activity where social talk occurred and the discourse was diverse, the resources were a focus for establishing and maintaining social relations with the learning of mathematics being of secondary importance. The fact that the teacher had to visit the group three times during the activity to refocus the group and to reiterate the task suggests group work comprising transitional and/or social talk is not an efficient or effective vehicle for children to learn mathematical concepts.

4.4.7 Analysis of practitioner-led talk during group work

The language used in practitioner-led talk during group work confirmed the findings of my Master's research in that practitioner-led discourse displayed the authority and control of the practitioner (see section 2.3.7). Also validated was the use of institutional ethnography as an approach to the methodology. The power relations identified by Smith (1987) as a fundamental structure were exemplified in this research in the relations between practitioners and children revealed by language they used. Practitioners' language was formal and stylised, structured into sentences that were focused on the tasks of teaching and assessing learning
(Alexander, 2004b). The forms used have been described above. Grammatical structure was not complex, but a common syntactical device used was to run several short sentences together into a string of instructions. This presented the children with many words to remember before the instruction was completed.

The instances of incomplete utterances of learners during teacher-led group work were low, confirming findings from the utterance analysis (see section 4.3.6.1). Sentences were short but complete and grammatically correct. They were predominantly uttered without hesitation. It is tempting to conclude that this supports the proposition that children accumulate a bank of prototypical short sentences and sentence fragments that they recall from memory when needed (Pinker, 1994). Specific vocabulary would be slotted into the prototype to reflect the sentence context. In a mathematics lesson it would be expected that subject specific vocabulary would be slotted into the prototype. Use of the new vocabulary embedded in the appropriate prototype and also as discrete words in the child’s personal and individualized language bank would be assimilated by the child through use and eventually accommodated as subject specific language. Words used discretely or embedded within sentence prototypes would be used in answer to the practitioner’s formative assessment questions to demonstrate not only the knowledge and understanding attained. They would also be used to understand succeeding concepts and make links with connected concepts as Meyer and Land (2006) predicted. However, analysis revealed only one instance providing potential evidence for this in Nov/Class 2 with a Year 1 child. The extract is given in section 4.4.2 above. Pinker’s (1994) research that revealed the fragmentary nature of children’s early speech resulted from the analysis of the discourse of pre-school children. It is therefore possible that the children observed for this research were too competent in their use of language for the components within its construction to be identified.
As has been observed above both teachers and teaching assistants used discourse markers. To reiterate discourse markers in the classroom context alerted children to the fact that something important was to be said and they should concentrate (Gee and Green, 1998). As there was little social language, and most language was focused on mathematics or the procedures in which it was embedded it can be inferred that the practitioners expected the children to be attending to what was being said most, if not all, of the time. Nevertheless, the practitioners identified times when either more focused attention was needed or the children’s concentration was waning. Discourse markers were also used to show that the practitioner herself was refocusing. For example, Class 2/Teacher preferred the signpost ‘Right, then’, Class 2/TA used the more informal ‘OK, guys’, Class 3/Teacher’s frequently uttered ‘Listen carefully’ and Class 3/TA used a simple ‘OK’. Two issues arise from this consideration of discourse markers. Firstly the children had to be aware that the use of the practitioner’s preferred discourse markers meant that they should increase their attention. This knowledge of individual teacher talk is an essential prerequisite to children recognising that something important for their learning is about to occur. Working consistently with the same practitioner is a factor in recognition of discourse markers. The practitioner’s use of voice and body language was also important (Argyle, 1988; Knapp and Hall, 2006). This presupposed a contrast with the tone/volume and body language used predominantly in the lesson delivery. Class 2/Teacher’s good practice in this area during whole class input has already been discussed, as has the overuse of discourse marking by the Class 3/Teacher.

An unexpected result from utterance analysis confirmed by total speech analysis was that instruction in mathematics was more frequent in the groups working with teaching assistants than with teachers. The highest level of instruction in mathematics was shown by Nov/Class3/TA. The frequency of her sentences of instruction in mathematics is the only example of a practitioner’s utterances in
this category being greater than that of her instructions regarding procedures.

This practitioner also used eliciting questions more than any other, and was the only practitioner to use confirming statements to answer mathematical questions more than those directed at procedures (Mercer, 2000). She was working with two children with special education needs (SEN). One child was Afrikaans with English as a second language. The other had a statement for difficulties with both language and mathematics. The teaching assistant had to repeat very simple instructions about the mathematics of constructing the two times table using cubes with these children, for example:

November/Class3/Gp4/TA: Eight! Good girl! Leave them separate [The cubes organised in groups of two] because you're going to do two add two add two add two equals eight.


November/Class3/Gp4/TA: You do it four times, four times. One, two, three…good girl! Well done!

November/Class3/Gp4/Child A: One, two, three…

November/Class3/Gp4/TA: Oh, did you need to count from one again? Did you need to count from one again? We've got two, four, six, we've got six, another two is…

Discourse extract 27: Effective use of repetition with SEN children

Nov/Class2/Gp1/TA was working with a large group of eight children but her level of mathematics instruction was high, closely mirroring the sequence and language used by Class2/Teacher. Although the teaching assistants could concentrate solely on the children with whom they were working, the teachers also had to manage the whole class. In both classes, the teachers were supporting other groups than the ones with whom they had planned to work. This demonstrated the value of teaching assistants to the effectiveness of focused learning. Nov/Class2/Gp3/TA was also adept at modelling what she wanted the children to do and in using an additional discourse marker of stating what she was intending to do. The engagement of this group was very high throughout the group work session.
4.4.8 Children’s talk in unsupervised group work

Total speech analysis revealed a progression from Reception to Year 4 in the discourse that took place during unsupervised work. The progression involved different levels of directed, conditioned and social talk. To illustrate this, extracts from unsupervised group work in each class will be presented and discussed.

Class 1

Unsupervised interactions in the Reception class were characterised by social talk or no talk at all. Different teachers led the two sessions observed. The first teacher, Nov/Class 1, had been a hairdresser before having her three children. She had worked for two years in the schools as a learning support assistant and two years as an unqualified teacher. Although engaged in completing her BA Honours, her intention being to progress to QTS, her current experience of teaching was limited. Her unsupervised activities involved a paired painting activity, a number programme on the class computer, sorting bugs into sets, playing with a model farm and letter writing practice. These activities generated social but not mathematical language. The mathematical computer programme had visual and aural components that generated passive involvement with subject language. As the children were encouraged to engage with the programme singly, there was no spoken language interaction.

Her activity, in which children worked in pairs, involved them choosing items of doll’s furniture from a box and, using the language of position, placing them within a doll’s house. As was seen in section 4.2.2.5, this was only moderately successful as the number of times key words were used during the activity was infrequent. Periodically the teacher would leave the doll’s house group to moderate the behaviour of other groups or to focus them. As has been indicated, the children either played separately with the dolls and their furniture or engaged in social talk. The following exchange is typical (see Appendix U video clip 8):
Discourse extract 28: Group play in Reception

At this point Nov/Class 1/Child A stops trying to socialize and talks quietly to her doll whilst Nov/Class 1/Child F places her furniture in the doll’s house. This is an example of Toolan’s (1996) belief that language is essentially other-oriented situated behaviour. Here only one child is other-orientated so no speech acts take place. Also Toolan, reflecting both Bourdieu (1989) and Heidegger (1962), maintains that the totality of what an individual has been, is, and wants to become is brought to each speech encounter and interaction. This too is discernible in the dispositions of the two children involved. For Heidegger, children are more truly ‘authentic’ in *dasein* than adults, as they have had less time to be socialized.

The second Reception class teacher (March/Class 1/Teacher), a supply teacher, was very experienced, having taught the age group for 25 years before leaving fulltime work. She covered the class for a term whilst Nov/Class 1/Teacher was in hospital. The lesson recorded took place at the end of March, shortly before the Nov/Class 1/teacher returned so she knew the children well. Her lesson objective was to reinforce counting backwards from 20. Her lesson revolved tightly around the language of number. All the children chanted the numbers one to ten in order
with the visual stimulus of toy pigs, and all children sang ‘Ten little pigs’ that involved counting downwards. March/Class 1/Teacher encouraged the use of fingers. Real coins in a bag were used to count down from 20 alongside a number line. Questions were asked to reinforce the visual and kinaesthetic stimuli (Smith, 1998). The related unsupervised activities included a sorting activity using farm animals. March/Class 1/Teacher said to the children (Appendix U video clip 9):

March/Class 1/Teacher: We've got lots of animals. I would like you to sort the animals because the animals like to live together in groups. So I would like you to group the animals into little houses, and homes and stables and farms so you’ve sorted all the animals out and then count how many in each house.

**Discourse extract 29: Use of unfocused language by Reception teacher**

The language used here is not focused and demonstrates the confusion inherent in the use of pragmatic language. The two uses of the word ‘group’, as a noun describing an entity and as a verb describing the activity of bringing discrete entities together, mitigated against the establishment of literal meaning (Yule, 1996) and might be confusing to children of this age, particularly as they had been sitting down for over 16 minutes and their body language clearly showed they were restless and therefore unlikely to be concentrating on what they were being told to do. As subsequent footage demonstrated, the boys who chose this activity played with the farmyard, particularly the toy tractors, and used no language of number. Their talk, when it occurred, was social talk. There were periods of silence as the boys explored their own worlds.

The second activity was introduced immediately after the first:

March/Class 1/Teacher: Over there, do you see all the toys lined up? Can you put a number on each toy and put them in
order? Child E is desperate to have a go with
that! There's some stickers, if you put stickers on
them all, then you have to put the toys in order
so they go 1, 2, 3, 4, 5, 6, 7, 8, 9, 10…
[Indistinct] And there are some other stickers if
you want to put your own numbers on.

**Discourse extract 30: Instruction in Reception (i)**

This was accompanied by gesture and pointing. However all but Child E showed
little interest. Four children looked at the carpet and one child looked at
March/Class 1/Teacher but did not follow her gestures. Child E subsequently
went to the toys but played with them. There was no evidence of counting
occurring. March/Class 1/Teacher continued:

March/Class 1/Teacher: Over there with the bricks it says ‘Build a tower. How
many bricks is it? Take one away. How
many are there now?’ Also I’ve got some vases
with flowers in. You can count how many flowers
there are in your vase.

**Discourse extract 31: Instruction in Reception (ii)**

No children engaged with these unsupervised activities. However the activities
led by the two practitioners, involving a counting game and counting as part of
making chocolate crispy cakes, were focused on counting and the children were
encouraged to count the visual objects verbally and kinaesthetically. The value of
the practitioner acting as a scaffold (Bruner, 1986; Vygotsky, 1986 trans.; Ben-Zvi
and Sfard, 2007), encouraging children to construct knowledge socio-cognitively
focused on meaningful activities, is essential for children's learning of
mathematics at this age. Conversely the value of unsupervised activities for
encouraging and developing mathematical language and reinforcing concepts is
doubtful.
Class 2

As was discussed in section 4.4.5, the dominant talk in the unsupervised periods for Nov/Class 2/gp 3 was transitional talk. Transitional talk acted as a bonding agent between children and enhanced the establishment of shared understanding and meaning of generic language upon which classroom talk could be built.

Transitional talk was not identified during the March/Class 2/gp3 observation. Again the group was unsupervised but this time they did not engage in talk unconnected with the task. For the whole of the unsupervised activity which lasted 17 minutes and 10 seconds, they concentrated on the task given to them and their discourse consisted of conditioned talk containing procedural or mathematical language. Several reasons could be suggested for this. Firstly March/Class 2/gp3 Child A appeared more mature. There was no evidence of immature language, such as ‘Silly dum-dum’, or self-centred and dominant behaviour. Secondly, the children were in pairs and not one group of four. They coped more successfully with this arrangement, working as a pair and not as separate individuals. Lastly, they understood the task which was to put numbers on a Venn diagram depending on their properties. This demonstrates the pragmatic linguistic tenet that language generated in speech acts cannot be divorced from context as context is the cause of their utterance as well as determining meanings. March/Class 2/gp 2 was left unsupervised for less than a minute when March/Class 2/Teacher checked on the work been done by March/Class 2/gp 3. March/Class 2/gp 3, consisting of mixed year 1 and Year 2 children, were working in three pairs on a similar task but with smaller numbers. They continued to work on task for half a minute and then the concentration of two of the groups lost focus. It would have been interesting to observe whether the talk would have changed to transitional or social talk, as in the Nov/Class
2/gp2 observation when the group contained only three children, or whether the children would have refocused on the task.

Class 3

In the session Nov/Class 3, group 1 consisting of six more able children in Year 4, was left to work unsupervised for most of group activity. The three Year 4 children of average ability in group 2 worked without supervision for the whole of the group activity. The task for both groups was to convert repeated addition sentences into multiplication sentences, to write multiplication sentences as addition sentences and then, as an extension activity, to write the multiplication sentences and division sentences. So this was not a group task in the sense of the Class 2 activities described above where pairs or the whole group produced one piece of work. Here the children were working on the same but individual worksheets. As Class 3/gp1/Child A demonstrated in both November and March recordings, discourse was not essential for learning. He worked silently by himself for most of the group work period. Interestingly he was of Afrikaans descent and had started at the school in the previous September. His English was not secure but his ability in mathematics had placed him in the most able group.

However the remaining children in group 1 engaged in talk. The recording of the discourse of Non/Class 3/gp 1 suggests that they were on task. There was no social talk. The purpose of the discourse between the children appeared to act as confirmation of their status as a distinct social group within the class and to check answers but not as a vehicle for socio-cognitive learning. A typical exchange contained principally task talk with the occasional social phrase, such as ‘...you are so annoying’ and ‘Oh my God..’:

Nov/Class 3/gp1/Child C: 54, I’ve got it, 54!
Nov/Class 3/gp1/Child E: Child C, you are so annoying!
Discourse extract 32: Transitional talk as a bonding strategy

However evidence from the video recording shows that there were times when the children were gesticulating and using facial expressions to communicate and to confirm relationships (Argyle, 1988; Knapp and Hall, 2006). The two boys Nov/Class 3/gp1/Child B and Nov/Class 3/gp1/Child C in particular were aware of the microphone and the video camera, and their talk appeared to be constrained by this knowledge. However by expression and body language these boys prevented each other from fully engaging with their work and disturbed the girls. Nov/Class 3/gp1/Child A, the Afrikaans boy, was unaffected. Also the video evidence revealed how much this group was relying on their fingers to count in ones, hence the exclamations in the extract above on losing count. The children were not using their knowledge of tables to reach the answers. Number lines had been provided but only two children made use of them. As evidenced above Nov/Class 3/gp1/Child B found his work ‘harder with a number line’, bringing to mind Cobb’s observation that resources such as number lines are not prototypes but metaphors that require interpretation. Also analysis of the worksheet demonstrates how little the children understood, or had the skills to complete, what was required of them (Appendix T) There was evidence of crossing and rubbing out on all worksheets. Many of the answers were incorrect. Analysis of this group’s interactions clearly demonstrated that Toolan’s (1996) perception that the totality of elements involved in speech acts should be taken into account when interpreting the meaning behind the words and sentences used. Those used in the following extract, where Nov/Class 3/gp1/Child B and Nov/Class
3/gp1/Child C are discussing the number line, suggest that the children are discussing length. The application of total speech linguistic theory demonstrates that they are discussing the mismatch between the size of the answers to the addition/multiplication sentences and the number line only going up to 100:

Nov/Class 3/gp1/Child B: It goes nine, nine, nine. How many nines do you have to do?
Nov/Class 3/gp1/Child C: Hey, this is going off the whole scale!
Nov/Class 3/gp1/Child B: I've forgotten....
Nov/Class 3/gp1/Child C: This is going to go off the whole scale. Child B, it's not big enough! This is 100 centimetres. To me, it's going to go off the scale.
Nov/Class 3/gp1/Child E: No, it's not.
Nov/Class 3/gp1/Child B: It can't be a metre.
Nov/Class 3/gp1/Child C: It says, look! Where's that metre then? How many nines do you actually have to do?

Discourse extract 33: Clarity given by total speech analysis

It is interesting to note that Nov/Class 3/gp1/Child C, who was linking his knowledge of length to his arithmetic task, was the only child to achieve level 4 in the QCA mid-key stage mathematics tests, thus confirming Askew et al.’s (1997) contention that ability to connect areas of mathematics demonstrates sound conceptual understanding.

Group 2 consisted of two girls and a boy. The boy worked by himself. The girls, friends outside of school, engaged in a mixture of conditioned talk, transitional talk and social talk. Their discourse in both observations was relatively sparse. There was greater evidence than for Group 1 that the children were confused about the connection between repeated addition, multiplication and division. Interestingly, the talk of Nov/Class 3/gp 2/Child G demonstrated evidence of language being learned as fragments remembered from conversations with others. The fragment ‘According to my calculations’ was used twice, in neither case being completed to form a full sentence. The phrase ‘Rest in peace’ and the
familiar ‘mate’ were also used. This language is scarcely extensive but it stood out in the discourse as being distinctive to Nov/Class 3/gp2/Child C.

All groups in March/Class 3 worked unsupervised in their group activities for some of the lesson on properties of numbers. Unfortunately some of the audio recordings were rendered indistinct whilst transferring from the field equipment to the server, so transcripts of March/Class 3 are incomplete. However, the video cameras had microphones so some speech was recorded, particularly that of the teacher. Also analysis was still possible because of the integrated approach adopted as a strategy. The learning intention was to sort numbers in a Venn diagram, although March/Class 3/gp4 used shapes. The video evidence demonstrated that the children’s ability to concentrate was greater than during the November observations. During the first activity talk was focused on the task. Apart from March/Class 3/gp3 there was very little task talk at all. The activities given were easily and quickly completed, although there were errors. There was also very little social talk, mostly contained in the time between the first task being completed and the teacher arriving to explain the second task. Children worked effectively in pairs, apart from March/Class 3/gp1 who were put into a two and a three but worked independently. The two girls in March/Class 3/gp4 worked together but the boy, March/Class 3/gp4/Child O, watched quietly and did not engage.

Social talk was minimal during the first task for all groups. However when it was completed, in less than five minutes by all groups, the children’s talk became social and all but March/Class 3/gp4 talked about the recording equipment. All groups were given a second task. Although all groups again engaged in transitional talk, the children were more boisterous and the work was not completed and contained errors. It is interesting to note that the teacher did not appear to notice the errors on the either task. As the worksheets were given to
the author at the end of the lesson, the errors were not able to be addressed in succeeding lessons.

4.5 Summary

Word analysis confirmed the finding of my Master’s analysis that non-subject specific mathematical language, that is lexical and everyday words, was used more frequently than subject specific technical language. Also confirmed was the finding that teachers used a wider range of mathematical language than their pupils. These findings suggest that the language used in mathematics lessons presents opportunities for misunderstandings and misconceptions to arise because of the imprecision of much of the language used. However word analysis did not reveal evidence of any word being used incorrectly or inappropriately in a mathematical context. Even in the Reception class, language was used accurately when it was used at all. Data analysis at word, utterance and total speech level revealed how dependent the existence of mathematics is on the language used by the Reception practitioners.

In all classes teachers and teaching assistants used language in relation to resources to establish literal meaning. This was particularly evident in the Key Stage 1 class. Confusion and opportunities for misconceptions arose, not through the inaccurate use of individual words in a mathematical context, but within the total speech context of teacher and classroom talk. The highly structured, high status and authoritarian domination of the teacher/teaching assistant during class input and practitioner-led group work noted in the Master’s research provided the context for misunderstandings to arise and confirm Alexander (2000), Smith et al. (2004), and Mercer and Littleton (2007) in their conclusions that the patterns in teachers’ classroom discourse have not changed.
Utterance analysis revealed that a predominance of closed questioning, emphasis on accurate completion of non-mathematical procedures and insufficient practice of mathematical language in context provided few opportunities during these parts of lessons for learners to construct independently understandings of mathematics in language and in relation to resources that were individually meaningful and developed autonomy (Ben-Zvi and Sfard, 2007). These opportunities arose predominantly during group sessions and were exposed through total speech analysis by the children’s use of conditioned talk. This register of talk had not been identified in the Master’s research although a difference between the talk of learners and teachers had been perceived. In the current research conditioned talk has been identified as an indicator of the construction of mathematical understanding taking place. Its context, focused group work, was not the only scenario in which this could happen. Total speech analysis revealed how practitioners could facilitate learning during group work though repeating mathematical facts and procedures in relation to resources and asking questions that were both formative assessments and indicators of possible pathways to understanding (Alexander, 2004a; 2004b). However, whatever the scenario, the factor of fundamental importance for the construction of meaning was that opportunities were provided for learners to ‘fill in the gaps’ left by the teacher/practitioner because of their pragmatic use of language or their insecure subject knowledge revealed by their language (Yule, 1996; Black and William). These opportunities enabled some learners to construct mathematical understandings despite practitioners’ imprecise and inaccurate use of language (Ben Yehuda et al., 2005). The mechanisms for this will be explored by relating the findings from this data analysis to the Learner/Teacher Dynamic.
5 Learner/Teacher Dynamic: Secondary Analysis

5.1 Introduction

The creation of the Learner/Teacher Dynamic arose from the Master’s research and subsequent critical evaluation of the literature. Discussion of the works of a number of theorists, including Bourdieu and Vygotsky, and recent Government publications on teaching, learning and assessment of the individual child, such as *Every Child Matters* and *Excellence and Enjoyment*, resulted in the presentation of a four dimensional Learner/Teacher Dynamic with the learner at its centre to illustrate the stance of this thesis on the relationship between learner, teacher and the focus subject, mathematics. Also ensuing from my Master’s research and preliminary studies to this thesis was the identification of three bridges linking the learner and the teacher who is closely linked to mathematics as its transmitter. The bridges identified were language, resources and assessment. In the original configuration of the Learner/Teacher Dynamic all three were given equal weighting as the research questions for this thesis focused on the role of language. Implicit in this is the proposition that there may be other bridges of equal weight of which language is one. It was anticipated that insights on the weighting of language as a bridge between teacher/learner and peer/peer relative to resources and assessment would be one outcome of this research. This proved to be the case. Effective use of resources and assessment are both principally language-based. However evidence from the empirical research clearly demonstrated that resources and assessment, though principally used in conjunction with language, were used by both children and teachers independently of language. An example of resources being used without language was recorded in Nov/Class3/gp 1 where the children were using
number lines and their fingers to calculate multiplications without recourse to language. An example of assessment being used without language was recorded in Nov/Class 2/gp 2 where the teaching assistant looked at the children’s workbooks to check their work was correct, but without comment. The bridges represented by arrows in the Learner/Teacher Dynamic represent resources and assessment stripped of language. Although the dimensions of the arrows are not to scale, the predominance of language as a bridge between learner/learner and teacher/learner is evident. Analysis of the data demonstrates that within language itself the primacy of spoken language above written English and symbolic language is clear. It is acknowledged that all language is embedded in non-verbal communication and that the importance of appropriate non-verbal language to teaching has been evidenced by data analysis. However as this research is focused on the role of language in the learning, teaching and assessment of mathematics, further quantification of the importance of non-verbal communication was not undertaken.

Figure 7: The Learner/Teacher Dynamic
Figure 7 illustrates the Learner/Teacher Dynamic representing the initial configuration of learner, teacher, mathematics, language, resources and assessment set within the physical and socio-cultural background of the classroom.

5.2 Findings from word and utterance analysis and the Learner/Teacher Dynamic

Discussion on the structuralist/semantic, pragmatic and total speech approaches to linguistics revealed that the Learner/Teacher Dynamic changed according to applied theory. Taking a structuralist/semantic stance the bridge of language between teacher and learner was simplified because words in both their spoken and written forms could be precisely used without recourse to interpretation because words and utterances have literal meaning. This approach to language of a biplanar static relationship linking words and their meaning resonated strongly with the prescriptive, centrally structured and controlled National Curriculum and Primary Strategy. It also reflected the institutionalized power relationships within the classroom where the teacher directs and determines discourse (Manke, 1997; Thornborrow, 2002) and the necessity of fluency as identified by Pimm (1995) and Ben-Zvi and Sfard (2007). Achievement in mathematics taught according to these documents is tested nationally through the SATs and statistics published accordingly. It is because of the existence of these results that The Primary Framework can state that: ‘Nearly a quarter of 11-year olds are still not confidently attaining Level 4 or above in mathematics by the time they leave primary school’ (2006a:2). There is a sense that such a curriculum is assessment driven. In the classroom utterance analysis revealed that spoken language was used extensively for formative assessment but not as much as it was used for instruction, confirming observations by Alexander (2004b) and Mercer and Middleton (2007). Conversely the extent of written language used for both instruction and assessment was minimal, but more was used in the worksheets or in exercise books than practitioners used whilst
instructing. Although learning intentions were displayed in four out of the six lessons observed (no learning intentions were displayed in Class1) and the Class 3 teacher on one occasion mentioned success criteria, the open-ended questioning techniques and peer-peer and self-assessment advocated by AfL (Assessment Reform Group, 1999) were not evident in the research school. Smith et al.’s observation (2004) that teachers’ discourse practices had not changed is still applicable in the research school.

Emphasis on the importance of language in the teaching and learning of mathematics in national documentation has decreased. Mathematical Vocabulary (1999c) is not mentioned in The Primary Framework (2006a). Although there are issues with an approach that equates the learning of words or phrases with mathematical understanding, this research has demonstrated the existence of literal meaning and that the children used mathematical vocabulary correctly in a mathematical context. However, The Primary Framework states that learning objectives are to be: ‘reframed in language children can recognise and can be used to set group or personal learning goals’ (2006a:66). This research has demonstrated that such an approach is simplistic. Structuralist/semantics, pragmatic and total speech approaches to linguistics all contribute to children’s meaningful constructions of mathematics. In particular, this research has shown that children need to ‘fill in the gaps’ (pragmatics, Yule, 1996) in their personal understanding embedded in habitus and dasein (integrational linguistics, Toolan, 1996) left by their teachers’ demonstrations and explanations through the conditioned talk encouraged by focused group work. Attention should be given by teachers to the implications of the language they use at word, sentences and total speech levels. Some advice on this within The Primary Framework would be helpful.
The findings from word analysis demonstrate that this mode of the Learner/Teacher Dynamic reflects practitioner-led discourse at class and group level. The introduction or reinforcement of key vocabulary was part of each of the lessons observed, the intention being to establish shared understanding, in other words literal, context-dependent meaning. However the analysis showed that the range of words used by practitioners was not focused on the key vocabulary. Lack of repetition of some key words did not provide sufficient opportunity for them to become accommodated in memory. Also according to the developed Shuard and Rothery analysis technical vocabulary, the subject specific language of mathematics, was used less often than lexical and everyday language.

![Bridge of language.](image)

**Figure 8: The Learner/Teacher Dynamic configured to reflect the structuralist approach to linguistics**

Everyday language, where words have different meanings when used in a mathematics lesson than when used in the everyday world, were used more often than lexical words that do have the same meaning in the two contexts. There was ample opportunity for misconceptions and misunderstandings to arise. However this was not identified in the word analysis, giving further support to the
existence of literal meaning and the relevance of a structuralist/semantic approach to the study of language in the learning, teaching and assessment of mathematics.

According to a structuralist approach resources, being part of the physical and socio-cultural context of the lesson, would not be acknowledged as a necessary frame for the communication of literal meaning. Following the line of argument discussed in section 2.3.4 it can be construed that resources would be regarded as neutral and insignificant because they arise from a shared cultural, ideological heritage. Therefore they should be removed from the Learner/Teacher Dynamic, as should the physical and socio-cultural-context of the classroom. The resulting configuration of the Learner/Teacher Dynamic is illustrated in Figure 8 above. Data analysis of the class observations revealed that little assessment without language, either spoken or written, took place. Therefore the dimensions of the arrow representing the bridge of assessment in Figure 8 are significantly smaller than that representing language. However there is no connection in terms of scale between the dimensions of the two arrows.

5.3 **Resources and a pragmatic approach to the Learner/Teacher Dynamic**

However, resources were used in all observations. They were an integral part of the teaching input, confirming Wertsch’s (2002, 2007) view that they are fundamental tools in mediation for learning. In all instances they were used to bridge the divide between the physical three-dimensional real world and the abstract two-dimensional world of mathematics though, as the analysis of the interviews demonstrated, teachers and teaching assistants were not explicitly aware of this. However, although resources were used principally in conjunction with spoken language, it was clear that the pupils used resources without recourse to language, for example in examining the three dimension shapes in Nov/Class2/gp 2 and in cutting out and sticking the illustrations of three-
dimensional shapes onto the Venn diagram in Nov/Class 2/gp 3. Also resources exist in classrooms as part of displays, or as part of teacher’s input as in the use of the interactive whiteboard during Nov/Class 2/Teacher’s input of shape. The children see the resources but do not always externalise through language their thoughts on them. Hence the dimensions of the arrow representing the bridge of resources in Figure 9 below are greater than that of assessment but less than that of language.

Discussion in the literature review confirmed Bruner’s three modes of representing experiences (1964) in relation to mathematical resources. To recap, the enactive mode involves some form of action in the external world that includes the manipulation of physical objects, the iconic mode involves representing those ideas using pictures and images, and the symbolic mode representation through language and symbols. However, whereas Bruner placed physical objects in his enactive mode, the discussion arising from the literature review places them in a transition zone that equated to his iconic mode (see Table 7). The rationale for this is that physical teaching resources could be seen as having two forms, the first being objects in the external world and the second being ‘objects designed to represent explicitly and concretely mathematical ideas that are abstract’ (Moyer, 2001:176) and are not to be found in the everyday world. Both forms were noted in the observations. Examples of the former were the coins used in the March/Class 1 lesson and the cereal packet used in Nov/Class 2’s lesson on two and three dimensional shapes. Examples of the latter were the Multilink used in the Nov/Class 3 lesson on multiplication as repeated addition and the plastic rings used to create a Venn diagram in both March/Class 2 and Class 3’s lessons, both on properties of number. However there were categories other than these identified in the observations. One comprised Learner/Teacher Dynamics of real world objects, for example, the farm animals in March/Class 1’s additions to 10 activity and the doll’s house in
Nov/Class 1’s activity on positioning. These equate with Ben-Zvi and Sfard’s ‘object-level learning’. Another was the resource consisting of worksheets. Worksheets took various forms and were used as assessments summative for that lesson. Examples are the form of language and space for writing answers as used in Nov/Class 3, illustrations of shapes with closed procedure utterances (Appendix T) and Venn diagrams with illustration of shapes to cut out and stick in the appropriate area (Appendix T). In the latter the illustrations of three dimensional shapes were not well-drawn. The word banks used by Nov/Class1/gp 1 were a different type of resource. The three-dimensional shapes with extractable two-dimensional nets were another. Despite the variations, the fundamental three part categorization indicated in the table below, stands with additional categories located in the transitional iconic mode, their position dictated by their closeness to either symbolic or enactive modes.

<table>
<thead>
<tr>
<th>Bruner’s modes</th>
<th>Symbolic mode</th>
<th>Iconic mode</th>
<th>Enactive mode</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brain processing function</td>
<td>Grammatical processing</td>
<td>Semantic processing</td>
<td>External world information processing</td>
</tr>
<tr>
<td>Mode representation</td>
<td>Language and symbols</td>
<td>Pictures and images</td>
<td>Physical objects</td>
</tr>
<tr>
<td>Resource</td>
<td>Abstract mental imaging</td>
<td>Manufactured manipulatives</td>
<td>Real world physical objects</td>
</tr>
<tr>
<td>Related language</td>
<td>Technical mathematical language</td>
<td>Lexical mathematical language</td>
<td>Everyday mathematical language</td>
</tr>
</tbody>
</table>

Table 7: Relationship between Bruner’s modes, resources and language

It was proposed in the review of literature and identified by total speech analysis that the area most likely to produce misconceptions in mathematics is the transitional area between the real, external three-dimensional world and the abstract, internal world of thought mediated by language and its symbols because of the potential to misinterpret resource and language. The latter equates with Ben-Zvi and Sfard’s (2007) meta-level learning. This was evidenced
in the Nov/Class 2/gp 3 observation where the task of reading the instructions and translating them to actions with poorly drawn cutout illustrations of three-dimensional shapes proved to be difficult. This was clearly demonstrated in the language used by the children as well as their behaviour, both of which became social in orientation. In March/Class 3 the resource of a portable whiteboard on which was drawn a Carroll diagram also caused problems when it was used with imprecise language (Appendix U video clips 6 and 7). On an individual level, Nov/Class 3/gp1/Child B stated that he found the number line unhelpful: 'It's harder with a number line. How many sevens do you have to do?' This supports Cobb’s (2000) assertion that number lines have to be interpreted by learners and should not be regarded as number and operational equivalents. Inappropriate resources for individual learning styles can also cause difficulties because children expect that the resources given to them by practitioners will help them successfully complete the task. It was interesting to note that in both Nov/Class 3/Groups 1 and 2 most children preferred to use their fingers for counting in their multiplication as repeated addition task than to use the number lines given to them.

The discussion above suggests that a pragmatic approach to linguistics more closely reflects classroom discourse than a structuralist/semantic stance. Clearly resources, which are an aspect of the physical environment or context, have a substantial impact on the teaching and learning of mathematics, and the validity of the written assessments displaying that learning. Resources can be used to teach, to learn and assess. However it is unlikely that any resource would generate mathematical concepts and thought on its own. Mathematics was defined in Section 2.3.1 as a systematic means whereby humans recognize, classify, manipulate, generalise and abstract the patterns they perceive in the natural world. Critical evaluation of the literature has suggested that Gardner (1983) may be correct in his belief that the brain is 'hard-wired' for mathematics in
a similar way that Chomsky (1957) argues that it is ‘hard-wired’ for language acquisition. However analysis of the data has indicated that initially mathematics is described and communicated as spoken English. Therefore the purpose of resources only becomes apparent when used in association with relevant and appropriate language, in other words, when learners are taught using language how to use resources in relation to the area of mathematics they are studying. Echoing Ben-Zvi and Sfard (2007) who observe that symbols and meanings are mutually constitutive and merge together, this finding suggests that resources and language should be mutually constitutive and merge together in the learner’s individual construction of meaning. From the data analysis it appears that the establishment of the bridge of resources has two stages. The first is to determine what the objects are as objects in their own right, for example the number cards in March/Class 2/gp 2’s number properties activity and Nov/Class 1’s box in the positioning activity (Appendix U video clip 1).

Figure 9: The Learner/Teacher Dynamic configured to reflect the pragmatic approach to linguistics
The second is to establish resources as objects to facilitate the teaching, learning, formative and summative assessment of mathematics. This was clearly demonstrated in Nov/Class 2/gp’s use of the three-dimensional shapes which contained two-dimensional nets. The children to their teacher’s frustration had to play with them first and describe them in real world terms such as ‘It looks like a flower’, ‘It looks like a fan’, ‘It looks like a pie’, before using them with the correct mathematical terminology of shape in relation to teaching and learning, formative assessment using spoken language and the summative assessment of the worksheets.

As a result of the above discussion the Learner/Teacher Dynamic has to be reconfigured to include resources and to increase the representation of language as both assessment and resources are dependent on it. Resources have a greater representation than assessment as resources are used not only in assessment but in teaching and learning. Pragmatics also takes cognizance of the context in which speech acts take place. This is the physical environment of the classroom and can be regarded as a resource (Rivlin et al., 1995; Pollard, 2002). However in section 2.5.1 on resources it was recognised that there were many areas covered by the term ‘resource’ and that detailed examination of all areas was impossible in a thesis of this length. It was proposed that the discussion would principally focus on manipulatives, being ‘objects designed to represent explicitly and concretely mathematical ideas that are abstract’ (Moyer, 2001:176). Therefore the existence of the physical environment is acknowledged in the Learner/Teacher Dynamic but its impact is not assessed.

5.4 Total speech analysis and the Learner/Teacher Dynamic

Although the insight that variation in distance between practitioner and learner existed emerged from utterance analysis through the identification of such intentions as regulation of behaviour, confirming observations made by Bakhtin
(1986), Vygotsky (1987, Toolan (1996) and Wertsch (2002) unsolicited statements and questions from the children and use of social conventions of politeness by practitioners, the extent of the variation and its impact on the Learner/Teacher Dynamic became evident through total speech analysis. Resources were used during the teacher-led whole class input and practitioner-led group activities. However utterance and total speech analysis revealed a difference in distance between teacher and learner during the teacher-led inputs and the practitioner-led activities. The greatest distance observed was during the teacher-led whole class inputs. In all observations individual children were asked to contribute to the input, for example taking a coin out of the bag in the March/Class 1 lesson on counting, and in Nov/Class 2 moving a shape into the Venn diagram on the interactive whiteboard. Nevertheless power was firmly with the teacher. Such interaction can be seen as confirmation of Manke’s (1997) finding of the teacher’s need to encourage collusion in order to maintain control. In the practitioner-led activities can be discerned a hierarchy of language reflecting the loosening of practitioner control with practitioners temporarily giving control to the learners in their groups. Nov/Class 1/TA maintained the tightest control. Although learners had more opportunity to speak in the group in comparison with the teacher-led whole class input, nevertheless the classic IRF (Sinclair and Coultd, 1975; Alexander, 2004b) exchange dominated. The teacher in Class 3 lessened the distance between her and her learners, particularly with the ADHD Child L, by allowing occasional equivalence of contribution to dialogue and moderating her status through her tone and cadence and by sitting on a child’s chair. Through facial expression and body language (Argyle, 1988; Knapp and Hall, 2006) this teacher showed her desire to engage with the child. However she maintained overall control by demanding compliance through collusive language, for example: ‘Child L, could you build 2s, please’. Her tone and cadence clearly communicated that this was not a question but a
directive. Questions functioning as directives were used by all practitioners for the same purpose.

In the discussion above, control had been managed by the powerful teacher in the teacher-led whole class inputs and in the practitioner-led group activities. However in establishing unsupervised group sessions teachers gave control, and hence power, to the children within these groups. By setting tasks, maintaining pace and visiting the unsupervised groups, teachers intended to maintain their power and control in that they were setting tasks that they expected the children to complete within the time set for the activity. However the success of this depended on the degree to which the children engaged with the task, or as Toolan would argue the extent of their faith, trust, goal orientedness, memory, imagination, intention, relevance and ‘acuity of perception’ (1996:12). It is proposed that the focus of the Learner/Teacher Dynamic changes with the handing of power and control to the children. However for the teacher to give power and control to her learners she must be confident that they have enough prior knowledge embedded in memory to engage with the task. The learners must show their faith and trust in the relevance of her choice of task and resources to enable their learning through compliance, accept her goal through their demonstrating their intention to complete the task, and display sufficient imagination and ‘acuity of perception’ to understand the precise nature of that goal. This means that the helix of the learner must also incorporate a curriculum strand, that of prior knowledge and current ‘acuity of perception’ of the potential of future learning.

Integrational total speech theory (Toolan, 1996) and theory of practice (Bourdieu, 1992) also suggest that the totality of individual experience is brought to any interaction in any context. Toolan’s belief that individually generated, not socio-culturally, generated meanings are supreme and literal meaning does not exist
has been refuted by both the word and utterance analysis presented in this thesis.

![Diagram](image)

**Figure 10: The Learner/Teacher Dynamic configured to reflect the integrational speech approach to linguistics, teacher-centred mode**

However total speech analysis has demonstrated the importance of acknowledging and responding to the *habitus* and *field* of each learner within the *field* of the classroom. Hence the Learner/Teacher Dynamic should reflect the socio-cultural context presented in its original configuration, with the addition of the curriculum strand of mathematics but with the teacher at its centre as in Figure 10.

### 5.5 Threshold concept theory and the Learner/Teacher Dynamic

The learner incorporating the curriculum strand in the form of prior learning resonates with the proposal put forward in section 2.4.5 that the space between learner and teacher is liminal in threshold concept theory terms (Meyer and Land,
As Bruner’s spiral, redrawn as a helix, is an integral part of the Learner/Teacher Dynamic, it was argued that liminal space and, by its relationship to them, threshold concepts were both accommodated within the Learner/Teacher Dynamic. To recap liminal space is entered by the learner when s/he moves from tacit knowledge to an understanding which may conflict with perceptions previously regarded as self-evident and gets ‘stuck’ here. Learners oscillate between the tacit knowledge they have of the new conceptual space and attempted understandings and even misunderstandings of the subject specific language, the subject matter, subject landscape and even world view afforded by the new perspective. It is the role of the teacher and teaching assistant, working as scaffolds (Bruner, 1974, 1986, 1990) to support the child whilst traversing this ‘troublesome’ period (Perkins, 1999) through the transference of knowledge and skills, gradually ceding control and support as the child gains fluency and mastery (Pimm, 1995, Sfard, 2008). Thus the knowledge and understanding owned by the practitioner becomes the property of the learner, accommodated within his/her prior learning.

However the process is not as simple as this. The evidence from data analysis has demonstrated that practitioners may also become ‘stuck’ in liminal space (Meyer and Land, 2006). Analysis of the teacher-led whole class input during the Nov/Class 3 lesson on multiplication as repeated addition was not so successful. In this lesson, the teacher through lack of understanding attempted to link doubling directly to multiplication as repeated addition. This is not possible: intervening steps are needed (see section 4.4.3). The teacher was locked in liminal space and total speech analysis revealed that she confused at least one of the children, taking him however temporarily into his own liminal space (Ben-Zvi and Sfard, 2007). This child was in the most able group in the class. As the other children did not voice any confusion they might have had and the
worksheets did not ask for knowledge of doubling to be applied, it can be assumed that other less able children were drawn into liminal space also.

Analysis of March/Class 3/gp 2’s interaction with the teacher on the construction of a Venn diagram (Appendix U video clip 7) showed that, despite the teacher’s insecure subject knowledge as evidenced by her language, entrapment in liminal space was avoided by the children as shared understanding was enabled by Child D questioning her teacher. The resulting discussion between members of the group and the teacher, continuing after the teacher had moved to another group, enabled the gaps in her exposition to be filled by the children according to their individual mathematical constructs. Therefore the space between teacher and learner has only the potential to be liminal and it appears that an aspect of mathematics that draws one learner into liminal space might not be ‘troublesome’ to another learner. Moreover, the children in March/Class 3/gp 2 appeared to conclude their constructions of mathematical meaning after the teacher had left their group, in other words, when the group returned to its unsupervised status. The conclusion emanating from this discussion is that liminal space created through teacher/learner interaction appears to be located not only in the Learner/Teacher Dynamic between the helix of learner and the central teacher/curriculum but also beyond it, defined by its own characteristics (see section 2.2.2). Further clarification will be obtained by considering how unsupervised group activities relate to the Learner/Teacher Dynamic. Also this discussion will illustrate how the identification of five different registers provides insights into the configuration of the Learner/Teacher Dynamic.

5.6 Speech registers and the Learner/Teacher Dynamic

Total speech analysis provided evidence for five differing speech registers. The teacher talk of the whole class input and the classroom talk of the practitioner-led group activities are the defining registers of the IRF exchange reflecting the
teacher/practitioner’s power and domination in the classroom and the teacher-focused configuration of the Learner/Teacher Dynamic (Sinclair and Coulterd, 1975; Manke, 1997; Thornborrow, 2002) The three remaining registers of conditioned talk, transitional talk and social talk were identified and discussed during analysis and these can be related to the learner-focused configuration of the Learner/Teacher Dynamic.

5.6.1 Conditioned talk

Conditioned talk is talk where the pattern of discourse reflects classroom talk in that it is focused on the task and on completing it. Conditioned talk does not follow the IRF pattern and utterance contributions demonstrate a greater degree of equivalence. Examples identified in the analysis were Nov/Class 2/gp2’s discourse on a three-dimensional shape being a cube or a cuboid and March/Class3/gp3’d discourse on the properties of numbers related to a Venn diagram. In conditioned talk the learners were continuing with the task unsupervised and were therefore still responding to power relations manifested in the teacher’s role. However the teacher or teaching assistant was not present but their power and control had become temporarily assimilated within the learner. Here the children were demonstrating a greater degree of self-surveillance (Foucault, 1980). So the teacher/curriculum disappears from the Learner/Teacher Dynamic and the external helix becomes another learner. It is suggested that children talking in this register are most likely to be learning socio-cognitively.

Data analysis revealed that when working with their peers children were using technical, lexical and everyday language in context that conveyed meaning for them about mathematics (Baines et al., 2009). They were demonstrating their learning through language, resources and recorded work for assessment. Learners asked questions, asked for advice, watched, copied, tried out strategies, assessed their own work. In setting up effective unsupervised activities teachers were transferring, not only power and control, but ownership
and responsibility. In this mode the Government’s personalized learning agenda (DfES, 2006b) of learning being learner-centred, knowledge-centred and assessment-centred is most likely to occur. Edwards and Mercer (1987) observation that such transference is the ultimate outcome of education is still acceptable.

The Learner/Teacher Dynamic resulting from data analysis confirms the modified integrational approach resulting from critical evaluation of the literature (see section 2.3.6) and is represented in Figure 11 below. This evaluation concluded that the implications of an unmodified integrational linguistic approach for the Learner/Teacher Dynamic would be that the external socio-economic context would disappear as a discernible entity to become embodied in each individual (Heidegger, 1962 trans.). However an individual cannot distance her/himself totally from the social and cultural influences that produced her/him and of which s/he is a part (Bourdieu, 1990 trans.). Evidence from the data analysis confirmed the modified integrational representation of the Learner/Teacher Dynamic, suggesting that the external socio-economic context in the form of prior experiences, perceptions and attitudes were embodied within each child’s habitus and also within the habitus of each practitioner. Also embodied within each child was the curriculum not only in the form of prior experiences, perceptions and attitudes but also in awareness of the potential for future learning. This resonates with threshold concept theory (Meyer and Land, 2006). The discussion here suggests that normalised socio-cultural norms exist external to the individual whilst personalised socio-cultural norms exist within her/him. This would accord with Bourdieu’s perception of ‘constructivist structuralism’ or ‘structural constructivism’ (Bourdieu, 1989).

During each speech event the focus of the Learner/Teacher Dynamic changed according to speaker and the external helix or helices according to who was
listening. The potential for liminal space to exist between and beyond learner/learner was present in the same way as it was between teacher/learner because in any dyad involving a speaker and a hearer one had attained a greater degree of mastery in mathematics than the other and learning occurs external to the relationship.

![Diagram of the Learner/Teacher Dynamic](image)

**Figure 11:** The Learner/Teacher Dynamic configured to reflect the modified integrational approach to linguistics, learner-centred mode

When the teacher returned to the group the Learner/Teacher Dynamic reverted to its teacher-centred mode. Each speech act takes place in the physical and socio-cultural context of the classroom which is unique but determined by the institution of education, the mechanism for normalising all lower schools in terms of curriculum, its delivery and assessment (Smith, 1999).
5.6.2 Transitional and social talk

Transitional talk is defined as talk less focused on the mathematical or procedural language evident in the practitioner-led and conditioned discourse and more on the underlying social relationships. Transitional talk shows that the internalized practitioner power and control that defines conditioned talk is waning. Foucault’s conceptualization of power as a multifaceted and constantly developing web of social and discursive interactions, including the increasing importance of self-surveillance and manifested ‘at its extremities’ (Foucault, 1980:96), has been evidenced so far by the closing distance between practitioner and learner demonstrated by the three registers already discussed. When children worked without the teacher being present a change of manifestation occurs. This was demonstrated by comparing conditioned talk to transitional and social talk. A criterion for conditioned talk is that the contributions between participants are equivalent. An example of transitional talk is given in section 4.4.5 during Nov/Class 2/gp3’s Venn diagram activity. It would appear that the distance between the speaker and listener in these exchanges did not vary from participants in conditioned talk. Nor did it appear that the distance changed during social talk, that is, talk unconnected with the task of learning, either of mathematics or the procedures associated with it. Social talk was also identified in Nov/Class 2/gp 3’s Venn diagram activity. The varying element, as Foucault (1980) and Smith (1987) would argue, was the teacher power and control embedded in the speaker and listener. During transitional talk the teacher’s influence could be identified in occasional utterances and phrases. In social talk that power appeared to have evaporated completely though the learners could be brought quickly back on task by the teacher visiting the group. However, for all meaningful purposes the Learner/Teacher Dynamic ceases to exist.
6 Conclusions and implications

6.1 Conclusions

This research has investigated the role of language and its implications for the learning, teaching and assessment of mathematics in the early years and the first four years of primary school education. My Master’s research indicated that language was important in these areas and that the use of real life, concrete, visual and human resources was also involved. However the research raised other issues, primarily on the potential difficulties in the imprecise and inaccurate use of language and the unquestioning use of resources. The perception of resources as being a bridge between the learner and the teacher of mathematics prompted a review of the literature to discover other bridges. These were found to be language and assessment.

A preliminary review of literature outside the focus of the research was found to be necessary to establish the ontological and epistemological stance underpinning the main research. The resulting position, influenced by Heidegger (1962 trans.) and moderated by Bourdieu (1990), dictated a predominantly ethnographic approach (Hammersley and Atkinson, 1994; Gee and Green, 1998) This being so, it became important to establish an external model against which the empirical research could be tested. A major outcome from the literature review was the establishment of a model termed the Learner/Teacher Dynamic within which language, resources and assessment grounded in a socio-cultural context were perceived as being the bridges between the learner and the teacher of mathematics.
Another important outcome was recognition of the need for a paradigm and methodologies that would reflect the holistic approach identified for the research. An institutional ethnographic paradigm (Smith, 1999) was evaluated as being appropriate with interviews and observations being the principal methodologies. This choice arose from consideration in the literature review of the prescriptive structures imposed on all primary schools by the institution of education though statutory and non-statutory governmental documentation determining the curriculum and related national assessments, initial teacher training and subsequent career development, and inspection through Ofsted and HMI. Because of this and the reliable video and audio technologies used to record data it is proposed that the answers to the research questions given below could be applicable in some degree to the learning, teaching and assessment of mathematics in other state schools with children in the four to nine age range, particularly lower schools in England and Wales. Further research is necessary to confirm this proposition.

The principal methodologies of interview and observation were effected through the use of video and audio technologies synchronised and recorded via a mixing unit onto a server. Data analysis confirmed that the Learner/Teacher Dynamic was robust, providing useful images with which to secure insights into learning and teaching interactions during mathematics lessons within the research school. It is acknowledged that the findings from this research can be applied with confidence only to the research school. However, the methodology of Learner/Teacher Dynamic combined with holistic observation techniques based on technology is applicable to all schools. Also the five registers identified by the application of linguistics enables detailed analysis of the use of language in relation to learning, teaching, assessment and resources. It is proposed that this methodology is a key outcome of this research and a contribution to knowledge in the field of education.
A further key outcome is the empirical evidence supporting the theoretical relationship between resources and language, brain function and Bruner’s modes identified through the review of the literature. This relationship clearly indicates that the area most likely to produce misconceptions in mathematics is the transitional area between the real, external three-dimensional world and the abstract, internal world of thought mediated by language and its symbols. The empirical research provided evidence that this area provided potential to misinterpret resource and language. However, review of the literature suggested that this area presented the ‘greatest potential’ for misinterpretation. The evidence arising from the current research is not sufficient to confirm this. Further research is necessary.

Also a key outcome is evidence to support to some degree Meyer and Land’s (2006) threshold concept theory in relation to the learning and teaching of primary mathematics. Total speech analysis, an approach resulting from critical evaluation of Toolan’s (1996) work on integrational linguistics, clearly demonstrated the existence of liminal space for both learners and teachers. Examples were identified where individuals, having grasped the existence of a new threshold concept, wrestled with applying their common sense understanding to an understanding which may conflict with perceptions previously regarded as self-evident. This was clearly observed in Nov/Class 3. Both some of the pupils and their teacher expressed through their language and non-verbal communication that they had entered ‘liminal space’ and were ‘stuck’ there (Perkins, 1999). The video evidence confirmed that learners were oscillating between the tacit knowledge they have of the new conceptual space and attempted understandings and even misunderstandings of the subject specific language and the subject matter. However it was identified that the word ‘threshold’ caused problems. The term ‘threshold concept’ suggests the passing through or over a barrier, a confined space, whereas the concept of liminality
suggests larger areas. As a visual image it is suggested that Meyer and Land’s alternative of ‘portal’ is more appropriate as it suggests the facility of a threshold concept to open up new vistas of learning and liminality.

A further issue with threshold concept theory in relation to mathematics teaching to four to nine year old children is differentiating between threshold and core concepts. Discussion in the literature review concluded that once the symbolic notation of mathematics had been mastered it appeared that initially all concepts were core concepts for children as fundamental mental networks of skills, knowledge and understanding in number, calculation, measurement, data-handling and shape and space were being established. However at some point these fundamental but separate mental networks were linked as threshold concepts are mastered. An essential area for research in applying threshold concept theory to the learning of mathematics in the early stages is to determine at what stage concepts become core and threshold. This could involve at the outset investigating the categorization of key and sub-learning objectives in The Primary Framework and mapping them against Meyer and Land’s five characteristics defining threshold concepts.

6.1.1 The role of peer-peer language in the learning, teaching and assessment of mathematics for children in the four to nine age range

Procedural statements dominated the peer-peer interaction during the times when a practitioner was not present with the group. The high incidence of utterances on this theme reflects the high number of instructions about procedures uttered by the practitioners, confirming research by Mercer (2000) and Alexander (2004b). The practitioners made explicit their concern that activities and the recording of these should be processed in a prescribed manner. Therefore it is not surprising that the children expressed uncertainty when the practitioners were not there to guide them.
Three registers of peer-peer talk were identified through the data analysis. These were all less formal than teacher and classroom talk. The registers, demonstrating levels of decreasing formality, have been termed conditioned talk, transitional talk and social talk. Evidence suggested that conditioned talk was the most effective talk for learning as children could through socio-cognitive strategies (Vygotsky, 1986 trans.) use their own language to discern the small steps in the inferential leaps (Yule, 1996) made by their teachers, work out problems together, inform their peers, share findings and reinforce each other’s learning (Mercer and Middleton, 2007). The learners’ language showed the relevance of aspects of structuralist, pragmatic and integrational approaches to linguistics, thus confirming a conclusion of the literature review that the various linguistic approaches discussed should be used to complement and not exclude each other. However, once learners have consolidated their understanding through conditioned talk, it is essential that teachers and teaching assistants then translate it into precise mathematical vocabulary to enable the most effective transition from the real, external three-dimensional world described by everyday language to the abstract, internal two-dimensional world of mathematics.

The finding of the Master’s research that teachers and teacher assistants used a wider range of mathematical words than their learners, and that this range contained more lexical and everyday words than technical words was confirmed. However, although this provided opportunities for misunderstanding and misconception, none was observed during this research. Confusion and opportunities for misconceptions arose, not through the inaccurate use of individual words in a mathematical context, but within the total speech context of teacher and classroom talk.

The sentence structures used by the children were, even in the Reception class, well-formed (Pinker, 1994). As with adult speech there was little hesitation during
discourse. The children were not taking time to consider what sentence structure to use, and which words they should choose to transmit their meanings most effectively. Sentences were uttered spontaneously. The instances of incomplete utterances of learners during both teacher-led and independent group work were low. Sentences were short but complete and grammatically correct, even when uttered as collective monologues. They were predominantly uttered without hesitation. This supports Pinker’s theoretical proposition (1994) that children accumulate a bank of prototypical short sentences and sentence fragments that they recall from memory when needed. Specific vocabulary appears to be slotted into the prototype to reflect the sentence context. In a mathematics lesson it would be expected that subject specific vocabulary would be slotted into the prototype. Use of the new vocabulary embedded in the appropriate prototype and also as discrete words in the child’s personal and individualized language bank would be assimilated by the child through repetition and eventually accommodated as subject specific language. Words used discretely or embedded within sentence prototypes would be used in answer to the practitioner’s formative assessment questions to demonstrate not only the knowledge and understanding attained but also be used to understand succeeding concepts and make links with connected concepts. This further confirms the existence of a core of literal meanings as identified by Saussure, (1983 trans.) and Chomsky (1957).

Another aspect of interest revealed by the utterance analysis was the children’s developmental understanding of the meaning of working in groups. A clear age-related progression in ability to work independently on teacher-identified tasks was observed. However this should not be regarded as wholly collaborative group work as children in all observations were working independently on tasks, not on producing jointly defined and agreed outcomes. Instead working in groups functioned to enable children to talk about their work and to check answers. The
ability to stay focused on teacher-initiated tasks increased with age. Years 1 and 2 appeared to be the critical years for developing this ability. The lack of engagement by individual children affected at this stage the ability of other children in the group to demonstrate their understanding of the focus of mathematics lessons. This suggests that working effectively in groups is a skill to be taught, perhaps in other subject areas, for example in outdoor and adventurous activities.

6.1.2 The role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the four to nine age range

The teacher-generated language identified in the current research confirmed the findings of the Master's research (Raiker, 2000) in that practitioner-led discourse was ritualistic (Sinclair and Coulard, 1975; Fisher, 1993). Analysis confirmed the findings of McHoul (1978), Edwards and Westgate (1982), Edwards and Mercer (1987), and Thornborrow (2002) that there is an unequal distribution of discursive rights between teacher and learner and that this manifests itself in an initiation/response/feedback pre-ordained format of discourse. The teachers and teaching assistants were firmly in control of the discourse during both the whole class teaching and assessment, and whilst teaching and assessing in the group activities. Two registers describing teacher/teaching assistant control of whole class and supervised group discourse were identified. These were teacher talk and classroom talk respectively, the former being the more formal. This was reflected in the stylised language as noted by Bernstein (1974), Bakhtin (1981) and Frowe (2001) and the structure of utterances that were focused on the tasks of teaching and assessing learning (Fisher, 1993; Bearne, 2002; Clarke, 2005). The utterance forms used manifested the cultural role inherent in teaching and assessing of the transmission of the norms and values of the dominant social group enshrined in Government policy (Bourdieu, 1990 trans.). Clearly identifiable categories of regulation and social convention (Bernstein, 1974; Ungar, 1987; Moll et al., 1993; Thornborrow, 2002) were discernible in
behaviourist patterns of stimulus-response (Sinclair and Coul
tard, 1975) in
assessment and of reinforcement, both positive and negative (Skinner, 1953).
Most language in the group sessions took the form of instruction, informal
assessment, confirmation and correction, all signposted by explicit discourse
markers as recognised by O’Brien and Yule (1995), Yule (1996) and Alexander
(2004b). By contrast, there was a structured absence of explanation. The
language used did not demonstrate a trial-and-error, problem solving approach to
learning but one of instrumental conditioning dictated by The National
Curriculum’s attainment levels, The Primary Strategy’s learning intentions and
The Curriculum Guidance for the Foundation Stage’s Stepping Stones, resulting
in behavioural outcomes of assessment that were measurable (Skinner, 1953).
This was particularly apparent when the teacher-led discourse was compared
with the peer-peer discourse which was discussed in section 6.1.1. Teachers
demonstrated that they were adept at keeping sentences short and of using
uncomplicated grammar. However a common syntactical device used was to
juxtapose several short sentences in quick succession resulting in a complex
sequence of instructions. Children found this difficult to remember as evidenced
by the succeeding questions asking for confirmation of, repetition of or
elaboration on what they were required to do. Identified by the current research
was the overuse of context specific deictic expressions (Crystal, 1987; Yule,
1996), preventing maximum repetition of mathematical language in relation to
children’s own socio-cognitive language for the purpose of reinforcement.

A significant finding from the research was confirmation of Alexander’s work in
that most utterances used by teachers in group work concerned procedures
relating to the activity through which individual learning was to be achieved and of
recording these procedures than with learning per se. This emphasis on
procedures confirms a behaviouristic approach to learning and teaching (Skinner,
1953) reflected in structuralist language (Saussure, 1983 trans.; Gardner, 1983;
Pinker, 1994). The longer the teacher worked with a group of children, the more discourse was centred upon and repeated procedural matters. Although the language of mathematics was used and thereby exemplified and confirmed, its use was subsidiary to the practitioner’s intention of reiterating procedure. The low level of children’s responses and lack of repetition of key vocabulary hindered children assimilating and embedding the language of mathematics. As the empirical evidence confirmed that the theoretical argument that mathematics is spoken language in the early stages of mathematics education, this is a cause for concern.

This instrumental approach to teaching and learning was demonstrated by practitioners’ use of closed questions in formative assessment. Practitioners were assiduous in asking closed questions to draw out mathematical knowledge. Open questions to encourage children to express their understanding in their own way were rarely asked. This approach did not probe the children’s listening skills, the essential prerequisite for effective use of language. The answers to these closed questions were short, single word answers of either number or key vocabulary items were more frequent than longer statements containing mathematical vocabulary. Analysis confirmed Sinclair and Coulard’s (1975) research showing that classroom discourse in type and pace was dictated by the teacher in initiation-response-feedback format. This was appropriate for whole class teaching in that critical evaluation of the literature confirmed by empirical research indicated that a structuralist approach to mathematical language (Saussure, 1983 trans.; Gardner, 1983; Pinker, 1994), encouraging precision of the vocabulary chosen (Pimm, 1995; Sfard, 2008) and accuracy of expression in teaching embedded in suitable non-verbal communication (Argyle, 1988; Knapp and Hall, 2006), was the most effective in transmitting subject specific knowledge. For this reason mathematical vocabulary should focus on the literal meanings expressed in technical and lexical subject specific language and not on
the prevalent everyday words that have multiple meanings during whole class teaching. It should also be focused on carefully chosen resources. The low focus of interviewees on resources, their use and the language associated with them, was a cause for concern. Analysis confirmed Ahmed et al.’s work (2004) showing that many teachers involved in their research did not fully understand how resources related to the mathematical concepts being taught. The lack of responses on teachers’ awareness of the use of resources, both concrete and human, as being essential and/or effective resources in lessons despite both being present in four out of the six observations was also a cause for concern.

6.1.3 The implications of the insights given by linguistics into the learning, teaching and assessment of mathematics for children in the four to nine age range

The implications of these insights from a range of contemporary linguistic approaches are significant. Consideration of various linguistic approaches has provided the insight that the language used by teachers in their whole class inputs should reflect structuralist linguistics (Saussure, 1983 trans.; Chomsky, 1957; Pinker, 1994), demonstrating precision of vocabulary and accuracy of expression, as this would be the most appropriate for mathematics teaching. However, critical evaluation of pragmatics showed that both pupils and teachers bring their own meanings of words embedded in their own individual experiences to the interaction (Searle, 1979; Bakhtin, 1981; Cobb, 2000; Mercer and Littleton, 2007). This suggested awareness of the possibility that problems in the learning of mathematical concepts by children might in part arise from and be compounded by misunderstandings of the meaning of the spoken language involved, and by teachers using language imprecisely and incorrectly. Critical evaluation of integrational linguistics (Toolan, 1996) provided insights into the uniqueness of an individual’s total experience manifested in the language used which acts as a springboard for individual linguistic interactions in context. This, combined with a philosophical approach that acknowledges the primacy of
habitus and dasein, enabled the identification of a hierarchy of registers. This in turn provided insights into the register of conditioned talk being the most effective for promoting learning.

The creation of the Learner/Teacher Dynamic established a visual image of the bridges between the learner, teacher and mathematics curriculum that constitutes an external, theoretical structure which the empirical evidence could evaluate and be evaluated against. Word, utterance and total speech analysis had revealed five registers of speech in the classroom, reflecting Foucault's conceptualization of power as a multifaceted and constantly developing web of social and discursive interactions manifested ‘at its extremities’ (Foucault, 1980:96). As he maintained, the role of power in discourse was identified by who had it and how it was manifested in the language used, in other words, in the context of this research teacher and learner discourse practices. The changing power relations as teachers ceded control and support (Fairclough, 1992; van Dijk, 1993) according to the children’s mastery of mathematics necessitated a series of reconfigurations of the Learner/Teacher Dynamic. The evidence from data analysis indicates that Figures 10 and 11 in section 5.6 reflected most closely the power/speech relations in practitioner-led activities and unsupervised learner activities although the reality in the classroom was not as defined as the Learner/Teacher Dynamic might suggest. Each mode has the capacity to include variation. In the practitioner-led activities, variation takes the form of distance between practitioner and learner; in unsupervised learner activities variation emanates from the loosening of teacher power and control embedded within the speaker/listeners. Effective use of resources and assessment are both principally language-based. However it is argued that language should be represented separately to prevent it losing its impact through being subsumed in these other factors. Also resources and assessment can take place without language. The bridges represented by arrows in the Learner/Teacher Dynamic represent
resources and assessment stripped of language. This emphasizes the predominance of language as a bridge between learner/learner and teacher/learner.

Evidence for the location of liminal space between teacher/learner and speaker/learner was identified but as a potential and not as a permanent feature of the preferred Learner/Teacher Dynamic. Also evidence suggested that that liminal space created through teacher/learner interaction appears to be located not only in the Learner/Teacher Dynamic between the helix of learner and the central teacher/curriculum but also beyond it, defined by its own characteristics (Meyer and Land, 2006). Further research is required into whether threshold concepts can be identified for groups of learners of primary mathematics and therefore explicitly addressed or whether they are personal and individual and can only be accessed indirectly.

6.2 **Implications of the findings for current policy and practice**

The most important implication of the findings summarised in the conclusions is for teacher training. The findings suggest the need to add comparative linguistics to the content of primary mathematics courses to enable student teachers to develop effective pedagogy. More emphasis should be placed in national documentation determining the content of mathematics and its teaching stressing speaking and listening throughout the phases. Also mention should be made of the different registers and the necessity of using structuralist, pragmatic and integrational approaches to language at appropriate points in a mathematics lesson.

Student teachers should be encouraged to undertake some observation of teaching with subsequent qualitative analysis (Brenner et al., 1985; Bogden and Biklen, 1992) based on whole class input by the teacher as well as peer-peer
interaction so that they achieve an understanding of the different registers and
how teachers could respond to each. This research demonstrates that the
spoken language of mathematics is of great significance because it forms the
principal bridge between teacher/teaching assistant and learner and between
learners. The research also indicates the importance of using the right resources
with the right language. Analysis has produced evidence to show that the area of
resource and related language was the most likely to produce misconceptions in
mathematics as it formed the transitional area between the real, external three-
dimensional world and the abstract, internal world of thought because of the
potential to misinterpret resources and language. Further research is needed to
confirm the transferability of this perception to other locations and phases in
education.

Student teachers should also be introduced to threshold concept theory (Meyer
and Land, 2006). Although the precise nature of threshold concepts in the early
phases of mathematics has still to be identified and would make a fruitful area for
further research, the mental imagery of an area where teachers and children can
become stuck is helpful as there is not a defined protocol for teaching
mathematics that will ensure success. Threshold concept theory encourages
awareness of individual problematic knowledge, a pre-requisite for the
personalised learning (2020 Vision Report Group, 2006) in mathematics and
effective assessment for learning (Assessment Reform Group, 1999). Also its
emphasis on language as being transforming reinforces its importance.

The Primary Strategy’s (2006a) emphasis on speaking and listening skills for
early years’ children should be expanded to include all age groups and primary
mathematics courses for student teachers. They should be encouraged to take
note of the hierarchy of registers and their relevance for meaningful and effective
learning and teaching. Whilst at university, student teachers should be
encouraged to teach their peers, selecting appropriate resources to stimulate talk and create effective mental imagery. As promoted by *Excellence and Enjoyment* (DfES, 2003a), as well as being made aware of current commercial products, student teachers should be encouraged to look creatively at the world around them, both inside and outside university, to raise awareness of mathematics in everyday life as a stimulus for meaningful activities in school.

In schools the establishment of In-service training for teachers on different approaches to linguistics, the different registers, the efficient and effective use of group work and of spoken language in learning and teaching should be made available. The content of such courses would follow those that could be studied by student teachers. This researcher was invited to the research school to present the findings of her research and as a result gave series of seminars on different approaches to linguistics, the different registers, efficient and effective use of group work and of the role of language in mathematics. These sessions were received favorably.

In the classroom, the findings suggest that there should be less emphasis on the procedures surrounding mathematics and more on the mathematics itself. Deictic expression should be recognised and discouraged. As has been well documented children should be encouraged to express their knowledge of mathematics through open-ended questioning (Assessment Reform Group, 1999; DfES, 2006a).

It is anticipated that the introduction of the above would play a crucial part in enabling those twenty-five per cent of children leaving primary school at levels below expectations to attain greater achievement and to reverse the continuing trend of early years and primary school teachers having insecure subject knowledge, not to mention fears and anxieties about mathematics.
6.3 Reflective review of the research

First and foremost, engagement with this research has been a privilege in terms of the journey in development of the researcher’s own cognition. She has learnt to become more focused and detached. She has always been able to perceive the wider perspective on issues. Engagement with this research has taught and encouraged her to give appropriate attention to detail. She now has greater understanding of how this attention to detail, combined with perceptions of the overview, allows critical analysis of reading and research data to be assimilated over time, resulting in the emergence of fresh perspectives.

The researcher has achieved greater awareness of the complexity of classroom interaction, particularly of the power relationships between teacher and children, and how these determine the use of language in the learning, teaching and assessment of lower school mathematics. The importance of a socio-cultural perspective within which individual children construct understanding and establish thought processes has become more evident. On a personal level this recognition of the separateness of individuals within the socio-cultural context and the uniqueness of individuals’ thought processes has revealed the necessity of communication and discussion. Collaborative talk with her peers and more experienced and knowledgeable others has enabled the researcher to become more balanced in her ideas and judgements. In particular, she has developed greater understanding of the effect of carrying out research in schools on both teachers and children. Her perceptions of the emotional impact and potential disruption caused by her research were heightened, and influenced her determination to lessen any adverse impact.

The researcher has gained some satisfaction in developing Bruner’s spiral curriculum by assigning three-dimensional and temporal perspectives to it. The resulting Learner/Teacher Dynamic model has been shown to incorporate the
concept of liminal space, a component of threshold concept theory, Vygotsky’s Zone of Proximal Development and Piaget’s concept of assimilation. Also pleasing is the identification of a transitional stage between the real, external three-dimensional world in which mathematics is embedded and the abstract, internal world of thought mediated by mathematical language and its symbols, and its potential to result in misinterpretation of resource and language. Again, pleasure has been gained in identifying its relationship to liminal space in threshold concept theory because here learners will become ‘stuck’. The researcher found the lack of teachers’ and teaching assistants’ understanding of the role of resources in the learning, teaching and assessment of mathematics concerning as resources were sometimes chosen because of being ‘fun’ or because they were available and not necessarily for their role in mediating learning and generating language.

The researcher was gratified that the findings from the research confirmed a holistic approach to language in that semantic, pragmatic and integrational approaches could be regarded as supporting and not opposing each other. The technology developed for this research made such a finding possible. Evaluation of the literature has demonstrated that such technology has not been used in lower school research before. This, together with the identification of a taxonomy of children’s classroom speech in terms of power relationships between children and teachers, could be helpful for classroom teachers to detect optimum learning interactions which the research suggests will be found during group work.

The main limitation of the research is also its strength. The research embraces two subject areas, mathematics and language, within the highly complex discipline of education. This juxtaposition has resulted in insights being gained and important links being made as has been discussed above. However it was impossible to read as deeply for two subject areas as it would have been for one.
Therefore the discussion admits at various points that further review and research into areas such as emotional literacy, motivation and non-verbal communication would have been useful but were beyond the scope of the current research. Also because of the complexity of the chosen subject areas and the discipline of education within which the research was situated and the wealth of data generated, a decision was made to confine the research to just one small lower school. This has resulted in questions over the reliability of the data and its analysis. A robust defence in the text argued that questions of reliability had been addressed by the institutional ethnography and the related case study methodologies adopted for the research. Also the technology developed for the research ensured that similarity in data collection in any number of school settings would be maximised. However analysis of data collected from differing schools using the developed technology and the taxonomy in combination with the Learner/Teacher Dynamic model would be of great value.

Insights could also be gained through further research into the extent of application of the developed technology, taxonomy and Learner/Teacher Dynamic model to other curriculum areas and phases. Included here is application to student/tutor relationships within subject areas in Higher Education. The researcher is currently involved in exploring potential improvements that could be effected in the quality of undergraduate dissertations through the methodologies and research outcomes discussed above. She has also used the Learner/Teacher Dynamic to illustrate and develop initiatives in the fields of staff development and course development within the university in which she works.

A rich vein of research could lie in exploring various aspects of threshold concept theory. In primary school education, valuable research could be carried out into the identification of threshold concepts in primary mathematics and the role of language in facilitating their transfer. This would involve investigating the potential
of exploratory talk to facilitate the establishment of threshold concepts and to address children’s difficulties with them.

Also of value would be research to determine whether threshold concepts occur in several children’s cognition at the time of teaching and learning a specific mathematical concept. If this is the case, teaching and learning strategies could be devised to address any learning difficulties resulting in children being thrown into liminal space. On the other hand, threshold concepts could be accessed by individuals at different times, including when other mathematical concepts are being taught. If the latter is the case this will necessitate an individual personalised learning approach with additional resources. These could be human, paper or online, or a combination. The researcher is currently engaged in such research but in a Higher Education context, related to the research skills underpinning the quality of undergraduate dissertations.

Although the journey of this research has been long and beset by professional and personal difficulties, it is one that the researcher could not have ignored or avoided. Insights that have influenced professional, social and personal philosophical stances, values and approaches have been gained. Above all, the complexity of classroom life has been accessed, observed and acknowledged, leaving the researcher with the understanding that however much is learnt there is so much more that is unknown.
Spoken Language and Mathematics

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ABSTRACT Teachers and learners use spoken language in the three part mathematics lesson advocated by the National Numeracy Strategy (NNS). This document recognises the importance of language by emphasizing 'the correct use of mathematical vocabulary' in the raising of standards. Research into the use of vocabulary in science suggests that the use of scientific words does not necessarily demonstrate conceptual understanding. Pupils and teachers appear to ascribe different meanings to scientific words because of their relative positions on the novice/expert continuum. To explore whether mathematical words could cause similar problems, data collected from six groups of teachers and learners was subjected to discourse analysis to provide evidence of how spoken language was used and how meaning and understanding were achieved. The implications of the findings on the use of language by both teachers and learners in the NNS mathematics lesson, including vital areas for reflection by teachers, are fully considered.

INTRODUCTION

The learning objectives of mathematics lessons are concerned with the acquisition of mathematical concepts by the children. The teaching and learning experiences organised by teachers, which can take days or even weeks to complete, are concentrated in single words or phrases, for example origin, cuboid, repeated addition, equivalent fractions. These words or phrases have precise meanings in mathematics, even though their meanings in non-mathematical language may not be so precise. This can be demonstrated by considering the word 'origin' as used in the mathematical context of the point where horizontal and vertical axes cross and as used in 'origin of the species'.

As mathematical concepts are to a large extent connected and hierarchical, it is crucial for the understanding of sound concepts and the subsequent development of mathematical thinking that the precise mathematical meanings of mathematical words are established. However, the language used in a mathematics lesson is not confined to such words. The discourse of discipline, instruction, explanation, demonstration, questioning, discussion, other subject areas and social interaction is all present. It follows that teachers should be aware of the language they use and be able to alert the children when mathematical vocabulary is being taught. The identification of key vocabulary and focused teaching on meaning should be detailed in lesson plans. Understanding of this
key vocabulary should be included in the assessment of achievement of learning objectives.

This paper explores the possibility that problems in the teaching and learning of mathematical concepts in part arise from and are compounded by the spoken language involved. If found to be true, this could have significant implications for the teaching of mathematics because the introduction of the National Numeracy Strategy (NNS) in 1999 has resulted in great emphasis on what is termed ‘the correct use of mathematical vocabulary’. Better numeracy standards occur, it is suggested, when teachers, among other practices, ‘use and expect pupils to use correct mathematical vocabulary and notation’ (DfEE, 1999a, p. 5). This presupposes that teachers understand the concepts contained in the vocabulary they use to teach. Briggs (1993) observed that many primary school teachers were confused in their thinking about many of the basic mathematical ideas underpinning their teaching. His findings have been confirmed by Sewell (1981), Cockcroft (1982), Briggs & Crook (1991) and Buxton (1981). The author’s own research with Price (Price & Raiker, 2000) also indicated this to be so.

The question to be addressed was why these feelings of confusion arose in the first place. Primary school teachers teach mathematical concepts they would have encountered when they were young children. A reasonable assumption would be that primary school teachers who have problems with the early stages of mathematics acquired these difficulties during their own primary years. Teaching mathematics during this phase involves the use of real life, concrete, visual and human resources, each of which involves spoken language to establish understanding. This suggests that inappropriate or imprecise use of spoken language could play a part in the formation of imperfect knowledge and even misconceptions in mathematics.

There are parallels in other subjects, particularly in science, to suggest this could be the case. Sizmur & Ashby (1997) observed that ‘becoming a scientist was as much about learning and using a spoken language as it was about carrying out experiments’. Their work explored this belief against a background of 1970s and 1980s research that revealed that, although children used appropriate scientific terms, many pupils held persistent misconceptions in many areas of scientific understanding. Carey (1985) and others (for example Driver, 1984; Strike & Posner, 1985; Sutton, 1992; Stringer, 1998) believe that faulty construction of meaning due to the language, spoken and written, was a major factor.

THE STUDY

Data from a piloted questionnaire revealed that the schools involved in the study varied considerably in size, had a variety of different controlling interests and were situated in a variety of locations. However, according to their OFSTED reports they all achieved within a range of average to well above average in mathematics, broadly in line with the quality of teaching with no unsatisfactory
teaching. Data was collected during numeracy lessons from one Year 2 class, two mixed Year 3/4 classes and three Year 4 classes, making six classes in total. These are referred to in the text as Class A4, Class 3/4, etc., the number being the year group. The discourse collected was from teacher–class interactions during the mental/oral starter and the introduction to the main teaching part of the lessons and also the sample group interaction during the related activities. These samples were groups of 6–8 children chosen by their teachers for observation. In five classes the samples were the above average groups; in the remaining class the group comprised a mixture of average and below average children.

The study attempted to interpret the spoken language used between teachers and pupils and pupils and pupils in the classroom by discourse analysis. This involved examining the everyday talk and explanations that arose from social activity. It was therefore an appropriate method of analysis for research that was focused on the contextualised dialogue emerging from mathematics lessons. The educational reality was the discussion itself. From it could be discovered ‘how teacher and children construct a shared account, a common interpretative framework for curriculum knowledge and for what happens in the classroom’ (Edwards, 1991). The most appropriate form of analysis of the mathematical vocabulary collected would be one that allowed the formation of categories but was sensitive to the nuances of spoken language. Such an analysis would have to be qualitative. Discourse analysis fulfilled these criteria (Edwards & Mercer, 1987). Any findings could then be related to the overall social structure of the classroom activities observed, of which the researcher was also a member. This approach was ethnomethodological in that it accorded with the statement of Benson & Hughes (1983) that ‘One of ethnomethodological interests is the explication of ways in which members, through their practice, produce a social structure of everyday activities, the aim being to describe those activities and show how they work’.

The role of the author was therefore of participant observer with the sample group, taking notes during the course of the lesson. This method of data collection was chosen because only one lesson per class was to be observed. Experience gained whilst gathering data for other research projects had shown that the use of a camera or video would have caused distraction because of being unusual and intrusive. Tape recorders had also been used in previous research to interview individuals and problems of distance, the lowering of voices and extraneous noise had made the discourse inaudible. In this study a record of whole class discourse as well as that between individuals in the sample group was required. Although occasionally children talked at once, it was possible to separate and record the different discourses, as there were periods when nothing was said, allowing time to catch up. This was also the case when one teacher talked very quickly. Such moments might have been lost if conversation had been recorded on tape. A further advantage of note taking was its facility of recording accurate sequencing of verbal and non-verbal communication from all areas of the classroom.
The data collected by note taking during the lessons observed was analysed by word analysis based on categories identified by Shuard & Rothery (1984). Their work demonstrated that mathematical language was more complex than everyday English. Mathematics uses a technical vocabulary that overlaps with the vocabulary of everyday language. This can cause confusion and the development of flawed understanding.

Outside the lessons data on the subject-specific vocabulary to be introduced or reinforced during them, gained from teachers' lesson plans and the questionnaire, was analysed. Also, a simple form of concept mapping was used to gain insight into the meanings attributed by the children to this subject-specific vocabulary. Concept mapping as developed by science educators enables teachers and students to produce together representations of the students' concepts in a domain (Carey, 1985; Stringer, 1998; Kinchin, 2000). This was important because, as Carey argues:

First, experts represent relations among concepts different from the relations novices represent among them …. Secondly, patterns among these new relations motivate the creation of new, abstract concepts and schemata that are either not represented by novices at all or are not very accessible to them. (Carey, 1989, p. 110)

By comparing successive concept maps, the teacher can ascertain the students' depth of understanding through the recorded spoken language used and also assess his/her own understanding of the concepts he/she was teaching.

A pilot study soon revealed that the usual presentation of linking concept boxes as discussed by Kinchin (2000) was too complicated, as none of the children had concept mapped before. The procedure was amended to fit the age and knowledge of the process of the children and the purpose of the data collection. The author aimed to discover which words the children associated with a particular topic and thus concept mapping was used as an assessment not a teaching tool. This being the case, the teachers' part in the process, including self-evaluations of understanding, could not take place. This is an important aspect of concept mapping. Its relevance to the teaching and learning of mathematics invites further study.

The children were asked before the lesson to draw a spider diagram of, say, division. In the diagram they could give the spider as many legs as they liked but at the end of each had to be a word linked to that focus. After the lesson the children could add more legs if they could remember any new words related to their lesson. So this simplified version of concept mapping was designed to elicit some understanding of the children's prior knowledge, a crucial factor in the teaching and learning process according to Aubrey (1997), and the degree of impact of the lesson on their vocabulary.

FINDINGS
Different mathematical words and phrases used by teachers and children during the course of the observed lessons were identified and quantified in a range of
word comparisons. They were then sorted into words and phrases contained or not contained in the NNS’s Mathematical Vocabulary (DfEE, 1999a) and again according to Shuard & Rothery’s (1984) categories of mathematical vocabulary.

A comparison between the number of different mathematical words and phrases used by teachers and children during the whole class discourse parts of the lessons revealed that the range of words/phrases used by the teachers was 29–55 and the children 17–30, a significant difference. When the range of words used by the sample during their peer group activity was added to those of the teachers and classes (Fig. 1) it can be seen that ranges of words/phrases used by the sample groups were significantly lower than those used by the class when in dialogue with the teacher. Also the range of words/phrases used by the sample groups and the classes when in dialogue with the teacher was significantly narrower than those used by their teachers. This supports Bruner (1990) in his view that adults have a significant role in developing and increasing the pace of learning and challenges Piaget’s belief that there is little point in teaching until a child had reached a ‘point of learning readiness’ achieved through activity and self-motivated problem solving.

The evidence also raises the question as to whether the greater number of words used in teaching has an effect on understanding and, if so, was this effect positive or negative. Fundamental to this study was Vygotsky’s (1987) belief that word meanings evolve during childhood and that we cannot assume that when a child uses a word he means the same as an adult listener. The author also agreed with Piaget (1952) in that children and adults occupy positions on the same novice–expert continuum, a theoretical model linking the state of no knowledge to the complete achievement of potential. There are fundamental differences in thinking between children and adults in all areas, including mathematics. These can be explained in terms of specific alternative conceptual
frameworks and changes related to moving along the continuum from infancy to adulthood. If this was the case, the greater number of words used by teachers could be confusing, not enlightening. This was clearly illustrated in the following exchange from the observation of a lesson on coordinates in Class E3/4 where the teacher intended to ‘talk about’ horizontal, vertical and diagonal.

**Teacher** What is this secret sign? *(Asks child to come to the front to show horizontal with arm).*

**Children** *(Chorus, confidently)* Horizontal.

**Teacher** What is this secret sign? *(Asks child to come to the front to show vertical with arm).*

**Children** *(Chorus, confidently)* Vertical.

**Teacher** And this? *(Asks child to come to the front to show diagonal with arm).*

**Children** *(Chorus, confidently)* Diagonal.

**Teacher** *(Writing the words as she speaks and pointing to a 6 × 6 grid drawn previously on the board.)* Horizontal is across, vertical is up and down and diagonal goes across. What’s a column? *(Child, hesitates, points to the bottom row).* Who agrees? *(One or two hands go up.)*

**Teacher** What is a column?

**Child A** Top to bottom.

**Teacher** What was he describing?

**Child A** A row.

As most of the children had not reached that particular point on the continuum they did not associate column with vertical and row with horizontal nor the writing of the words with the grid. The teacher did not expand further on the connection.

Further issues arise from this exchange and the lesson plan on which it was based. Earlier in this paper it was proposed that the identification of a key vocabulary and focused teaching on meaning should be detailed in lesson plans and that understanding of this key vocabulary should be included in the assessment of achievement of learning objectives. This is based on the hypothesis that the understanding of mathematical words is fundamental to the development of sound concepts and mathematical thinking. The lesson plan for the coordinates lesson did include a learning objective on vocabulary *(to recognise maths vocabulary is related to a function)*, but this was related to the mental/oral starter on addition and subtraction revision. The learning objective for the main part of the lesson was ‘to describe and find the position of a point on a grid of squares with numbered lines’. No key vocabulary was identified. The lesson plan continues: ‘Talk about horizontal, vertical, diagonal lines. Using arms make rows and columns … ’ However, in the lesson itself the arm of one child was used to demonstrate horizontal, vertical and diagonal. The
responses of the children showed that the majority understood the meaning of these words. Arms were not used to demonstrate rows and columns and the children were clearly confused. As the teacher had not identified the key vocabulary it was impossible for her to think through how she was going to teach the concept of ‘row’ and ‘column’ effectively. She was not alone in this. None of the six teachers’ lesson plans indicated how they were going to teach the meaning of the key vocabulary and all teachers demonstrated haphazard and confused use of vocabulary in their explanations and instructions (Raiker, 2000). This reflects the findings of Briggs (1993) and others that many teachers were confused in their thinking about many of the basic mathematical ideas underpinning their teaching.

The lesson continued as follows:

Teacher  *(Pointing to where the two axes meet.)* Do you know what this point is called?

(About a quarter of the class put up their hands.)

Child The origin.

Teacher What is the next vertical number? *(A child is chosen and puts in 1.)* Is this right? *(Continues until both axes are correctly labelled. Some children are eager to be chosen, others are losing interest.)*

Teacher All the boys are Xs and all the girls are Ys. Mark on the grid. What do I call sets of numbers that give me a square?

(One or two hands go up.)

Child A Coordinates.

Teacher The first number is always ...

(Children are not sure. No hands go up.)

Teacher Is always across. So the second number is up. First team to get three in a row wins. *(Chooses a child. Offers a pack of cards with digits 1–6 written on them. Child picks the number 6.)* Where am I to go? And the second card? I’m going to go up. The first coordinate, across or up?

(A few hands are raised.)

Child Up.

Teacher No.

Child Across.

Teacher Across first. Now where? *(Chooses another child. Offers pack. Child takes a card. Watches teacher as she says ...)* From the origin to three. *(Picks a second card.)* Where’s the 5? Now I want to go up. *(Gets hold of the child’s hand and physically moves it up.)* Tell me when to stop.

(The child has no idea. Teacher picks another child. Offers the pack. Child chooses a card.)*

Teacher From the origin to five. Where are you going?

Child Across. *(Picks another card.)*
Teacher Another five. Where are you going?
Child Up.

(Class getting restless. Teacher recognises this. Gives out worksheets. Briefly explains what to do.)

It is obvious from the above, confirmed by the concept mapping exercise, that the children had been taught coordinates previously. They were familiar with the language, but clearly many of them did not understand the meaning of origin. In the introduction to the lesson the children were confident with the meanings of the words horizontal and diagonal. The game could have been used effectively to reinforce these meanings, but this opportunity was missed. Instead the teachers’ use of ‘across’ and ‘up’ confused them.

The teacher also used ‘across’ and ‘up and down’ in the following explanation: ‘Horizontal is across, vertical is up and down and diagonal goes across’ in the introduction to her lesson. Mathematical Vocabulary (DfEE, 1999b), published alongside the NNS, contains the words and terms the then DfEE believed would facilitate understanding and contribute to the achievement of higher standards. ‘Across’, ‘up’ and ‘down’ appear in this list. If the DfEE was correct then these words used by the coordinates teacher should not impede learning because they are in the approved list. The extracts above suggest that learning is impeded and was confirmed by discourse from the other lessons observed. Word analysis using the Shuard and Rothery categories suggested the reasons why.

Shuard & Rothery’s (1984) work demonstrated that mathematical language was more complex than everyday English. Mathematics uses a technical vocabulary that overlaps with the vocabulary of everyday language. According to Shuard and Rothery there are three types of mathematical words.

- Technical words: words which have a meaning only in mathematical English, for example from the data divisor, axis, square centimetres.
- Lexical words: words which have, amongst others, a similar meaning in mathematical English as in everyday English, for example remainder, origin, altogether.
- Everyday words: words which occur both in everyday English and mathematical English but which can have similar and different meanings in mathematical English from their meaning in everyday English, for example points, change, difference.

Reference was made to the Oxford Dictionary and Roget’s International Thesaurus to assign words to particular categories.

The words used by teachers, classes and samples were categorised according to the definitions above and their frequency noted. The results are given in Figure 2. As can be seen, technical words are used least by all groups and lexical words are used more often than any other category for all groups. The ratios of the categories in each group are remarkably similar.

It can be argued that technical words have precise meanings that must be
taught in the classroom because they are specifically mathematical and relate to specific mathematical topics, for example the meaning of the words naming 3D shapes (sphere, triangular pyramid, cuboid) would be an integral part of a 3D space and shape lesson. These words would be used infrequently outside this context. However, lexical and everyday words used in mathematics lessons are used with varying degrees of frequency elsewhere and, arguably of greater significance, with meanings that are not precisely mathematical. Indeed, these meanings might not be mathematical at all. The lexical words ‘column’, ‘division’ and ‘make’ and the everyday words ‘points’, ‘change’ and ‘fair’ are examples. In the extract on coordinates ‘across’, ‘up’ and ‘down’ are lexical words. Their everyday and mathematical meanings are similar but the fact that they are not the same is significant. Vertical is ‘up and down’ but it is a precise up and down-ness.

The coordinates teacher’s assessment of the lesson was ‘Most of the group grasped the learning objective of the lesson but one or two would still benefit from more practice in grid work’. Below is the transcript of the discourse of a group activity which involved completing a worksheet entitled ‘Questions on Plotting Coordinates’. This worksheet asked the children to plot points on $5 \times 6$ grids by marking the position of points, villages (including the place name Millom, which the children were asked to label) and adding ‘two more points to the graph (sic) to produce a kite’. Note the incorrect spelling and use of mathematical words in this worksheet.

Child B  I don’t understand this.
(Children B and C working together.)

Child C  (Watching Child B) Going across first, not up. Look two, six.
Child B  No, you always go across first.
Child D  (Reading worksheet) What does Millom mean?
(Child A finishes quickly. Child E has trouble with question 2.)

Teacher  (To Child A.) Read question 2 and do what it asks.
(To Child D.) Read question 2 and do what it asks.

Child D  How do you label them?
Teacher You are not reading question 2 and doing what it asks. \textit{(To Children A and B.)} Is that a kite shape? It looks like a diamond. Draw a kite on the grid and label the coordinates. \textit{(A, B and D finish. Their kite shape is incorrect. E has the correct kite shape. There is trouble with the kite shape of C.)}

Teacher On the back there are three grids. On the first the axes are numbered, on the second the vertical axis is numbered, on the third neither are numbered. The first is a square, the second a rectangle, the third a triangle. Then write the coordinates. Remind me. Which goes first?

Child A Across.
Teacher Which goes up?
Child A Vertical.
Child B I don’t understand.
Child E This is hard.
Child D \textit{(Helps Child E with coordinates.)} That’s 1,1. That’s 1,6.
Child B \textit{(To adult helper.)} I have to do coordinates. I don’t know what they are.

Adult helper You’ve only got three coordinates for your square. Finish this off first.
Child D Oh, I forgot to put the numbers in.
Teacher \textit{(To B.)} Write the numbers in the brackets. Now our first coordinate is ...
Child D I don’t really understand the triangle with the boxes \textit{(the grid)}.
Teacher Three points, three sides. \textit{(Draws this for D.)} Don’t forget to put the numbers in first.
Child C Who put that O \textit{(pronounced as the name of the letter but meaning the origin)} in for you? That was hard.

The teacher’s assessment was optimistic. It was based on her own perceptions and the completed worksheets. The children managed to complete the worksheet correctly on the whole but the discourse reveals that the group relied heavily on Child D for direction. Another issue to note is the range of mathematical concepts incorporated in this exchange: vertical, horizontal, position, elements of number, order, kite, parallelogram, rhombus, grid, coordinates, axes, square, rectangle, triangle, points, origin, etc. If any of these concepts and the words representing them were not fully understood the teacher’s learning objective could not be fully achieved and would lead to faulty knowledge and the development of misconceptions. There were obviously problems with vocabulary, but neither the teacher nor the adult helper perceived this.

It must be said at this point that although four of the six teachers specified key vocabulary, none of them detailed in their lesson plans how they were going to teach the correct meaning of this key vocabulary. The questionnaire and information given verbally to the author by the six teachers taking part in the
study revealed that one teacher regularly used *Mathematical Vocabulary*, two referred to it ‘a little’ or ‘sometimes’ and the remaining three teachers did not use it at all. The teacher giving the lesson on coordinates fell into the latter category, although she did use many words in *Mathematical Vocabulary*. In fact, the match between an alphabeticised list of all words contained in *Mathematical Vocabulary* against those collected during the observations indicated that the teachers in the study were using the recommended vocabulary significantly more than the rest. Of the total number of mathematical words and phrases used by the teachers 63% appear in *Mathematical Vocabulary*. For the classes the figure was 68% and for the sample groups 58%.

An assumption can be made that ‘experts’ (teachers, adults and mathematically more able children) can extract the correct precise mathematical meaning of a lexical and everyday word and apply it consistently in a mathematical context, whereas ‘novices’ (children) would have difficulty unless they are taught. Teachers are encouraged by the NNS to ensure that a topic’s new vocabulary is clearly on view in the classroom. As with all displays, the words can then be referred to during the course of the lesson and their meaning connected to appropriate aspects of the related activities. Does this happen?

Analysis was made of the new subject-specific vocabulary and the vocabulary to be reinforced in the lessons. The frequency with which each word was spoken by teachers, classes and sample groups was noted (Table 1). Results indicated low rates of repetition by the teacher and that children used new and reinforced vocabulary in class dialogues with the teacher but rarely in activity sessions when working with their peers. This implies that these words were not be repeated sufficiently for them to become part of the children’s known mathematical vocabulary. Also, these words were not repeated and explained sufficiently for their precise mathematical meaning to be made clear to the children. As the children infrequently used the new and reinforced words during their group activities, they could not link them to the concepts they were building and reinforcing through those activities. The following exchanges from the group observations illustrate this. All group observations followed focused teaching on the chosen topic.

**Class E3/4. An AA group, lesson on coordinates.**

Child B  (*To adult helper.*) I have to do coordinates. I don’t know what they are.

(*This child had not used the term ‘coordinates’ in talking to her peers.*)

**Class D2. An AA group working on division with remainders.**

Child B  (*Working on the written problem: What is 13 divided by 3?*) I like the fours, they’re easy. Is it 3 divided by 4 or 4 divided by 3? I don’t know what three fours is. Twelve! (*Writes 3 ÷ 4 = 12.*)

**OMOHH! I’ve got to do a …… (*Writes r after the 12.*)**

**Class C3/4. An AA group working on remainders.**

Child A  Check that there’s 20. Now put it in boxes of six.

Child C  Three remainder two! Shall I throw these (*the two cubes*) away?
<table>
<thead>
<tr>
<th></th>
<th>displayed?</th>
<th>divide</th>
<th>division</th>
<th>multiples</th>
<th>remainder</th>
<th>multiply</th>
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<td>9</td>
<td>3</td>
<td>4</td>
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<td>1</td>
<td>4</td>
<td>0</td>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>B4</td>
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<td>fraction</td>
<td>equivalence</td>
<td>equivalent</td>
<td>numerator</td>
<td>denominator</td>
</tr>
<tr>
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<td>11</td>
<td>1</td>
<td>8</td>
<td>2</td>
<td>5</td>
<td></td>
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<tr>
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<td>0</td>
<td></td>
</tr>
<tr>
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<td>no</td>
<td>divided</td>
<td>remainder</td>
<td>round up</td>
<td>round down</td>
<td>divisible</td>
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<td>7</td>
<td>3</td>
<td>1</td>
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<tr>
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</tr>
<tr>
<td>Sample</td>
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<td>7</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>D2</td>
<td>no</td>
<td>share = y</td>
<td>repeated +</td>
<td>inverse</td>
<td>remainder</td>
<td>divide</td>
</tr>
<tr>
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<td>2</td>
<td>3</td>
<td>2</td>
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<tr>
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<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
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<td>vertical</td>
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<td>horizontal</td>
<td>coordinates</td>
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<tr>
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<td>7</td>
<td>3</td>
<td>6</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td>Class</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>Sample</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>E4</td>
<td>yes</td>
<td>area</td>
<td>surface area</td>
<td>centimetre</td>
<td>standard unit</td>
<td>perimeter</td>
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<tr>
<td>Teacher</td>
<td>2</td>
<td>1</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>Class</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
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</tr>
<tr>
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<td>0</td>
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<td>0</td>
<td>0</td>
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</tr>
</tbody>
</table>

Bold, new vocabulary; italic, reinforced vocabulary.
The low rates of repetition could explain why the children used a narrower range of words, using their own child-orientated language when talking to each other in preference to the adult language their teacher would prefer them to use. Vygotsky(1987), Bruner (1990), Dunn (1996), Robinson (1986) and others have all commented on how children use language differently to adults. Nevertheless, as Bruner, Vygotsky and their followers, but not Piaget, would have acknowledged, the teacher did have an impact by encouraging the children to use more ‘key’ vocabulary in the teacher–class dialogues than they would of their own accord.

This raises the question of whether this encouragement is sufficient for the children to develop their mathematical knowledge and understanding of the new vocabulary involved.

The evidence from the study suggests that focused talk during the group activity sessions provides essential reinforcement. Unlike the teacher–class discourses that were formal and controlled, the sample group discourses were free flowing and dynamic. Elements of the novice/expert continuum were revealed as children with firmer understanding of the concepts helped those who were in doubt to construct understanding. For example:

In Class C3/4 the children were working on the problem: how many £3 tickets can I buy if I have £2.25?
Child A Twenty-five pounds divided by 3 is 8 remainder one is 9 tickets.
Child B It has to be eight because you haven’t enough money.

In Class B4 the children have been asked to divide a 30 cm strip of paper into six equal pieces.
Child A I’m going to fold it.
Child G I’ve got an easy way, fold it into three pieces.
Child A (Starts to fold strip, then stops looking unsure. Watches others in group.)

Child G It’s easy with this ruler. It’s split into tens. (Marks off strips at 10 and 30 cm, then in between at 5, 15 and 25 cm.) One, two, three, four, five, six, yes!!!
Child A (Begins to measure strip in 5 cm intervals.)

The busy teachers missed these opportunities to perceive levels of understanding through spoken language, whereas the author was in the privileged position of being able to sit and observe, as did Driver (1984). In science she saw the acquisition of understanding as being constructed by the use of language by teachers and learners. This study identified children adopting both roles, using spoken language to construct their own understanding and assist their peers to construct theirs.

The children’s thoughts, reasoning processes, anxieties, perceptions of success and misconceptions were externalised during the group sessions but not in the teacher–class interactions. For example:

Thoughts

(S1) This is my bridge.
(K-A) I’m going to put my cubes into towers of four. (A4)
Reasoning
One-thirtieth is one centimetre on the ruler so to split it into six you measure in fives. (B2)

Anxiety
(A) I did it all wrong!
(F) I don’t get this. I put three-sixths. Anyone got a rubber? (B2)

Perceptions of success
(E) I think my works good.
(B) Why
(E) Because it’s neat. (D2)

Misconception
(A) Check that there’s 20. Now put it in boxes of six.
(C) Three remainder two. Shall I throw these *(the two cubes)* away? (C3/4)

Unlike the teacher–class discourses, all the children in this sample group were involved, although not all joined equally in the discussion. The observations revealed that instead of talking, some children watched manipulation of resources or the writing down of workings out and answers. It was possible that the latter could be termed ‘copying’, but as in some instances these activities were frequently accompanied by the ‘doers’ explanatory monologues, those watching might have been constructing their own understanding by being taught by their peers.

The indications from the concept mapping analysis were revealing and fascinating, providing evidence for the extent of children’s prior knowledge, their relative position on the novice/expert continuum, identification of special needs and indications of existing conceptual models as well as the impact of the lessons on vocabulary. For example, the vocabulary mapped by Child C quoted above, because of his misconception of remainder, suggested a sound understanding of the concepts: 1/2, 1/3, 1/4, 2/3, 3/4, add, divide, equals, halves, inverse, numbers, products, quarter, remainder, share, takeaway, times (the words added to the concept map following the lesson are in bold and include remainder). Clearly he did not understand the meaning of remainder in a mathematical context, although he used the correct subject-specific vocabulary.

The examples given above suggest that concept mapping as a record of spoken language could be a useful tool in the process of assessing understanding and identifying areas for concern. Further study into concept mapping for this purpose could be illuminating.

CONCLUSIONS AND IMPLICATIONS

The analysis discussed in this paper has shown that problems in the teaching and learning of mathematical concepts in part arise from and are compounded by the spoken language involved. This reflects the causes of some of the problems arising in the teaching of science. The study has demonstrated the hierarchical nature of mathematics and how confusion can arise if the precise
meaning of mathematical words is not established. Evidence for the hypothesis that pupils and teachers appear to ascribe different meanings to mathematical words because of their relative positions on the novice/expert continuum was identified. The crucial role of mathematical language in the building of sound concepts and subsequent development of mathematical thinking has been demonstrated. It has been shown that the teachers in the study, even though they were using vocabulary recommended by Mathematical Vocabulary, were not aware of the importance of this vocabulary and did not plan for its introduction, explanation of meaning and repetition. They did not distinguish between the differing purposes of language in a mathematics lesson and were therefore unable to alert the children when the essential key vocabulary was being taught. Understanding of this key vocabulary was not included in the assessment of achievement of learning objectives. Achievement was assessed as success in completing worksheets. The study clearly shows that one method of assessment is insufficient to gain meaningful insight into children’s understanding. Concept mapping is recommended as an additional tool, as is careful attention to children's talk. Above all, teachers must be aware of the language they use when teaching mathematics and that the recommended vocabulary contained in Mathematical Vocabulary should be used with caution.

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REFERENCES
DFEE (1999b) Mathematical Vocabulary (Watford, BEAM Education).


Appendix B: Bar chart of scores in reading, writing and mathematics from pre-2004 Ofsted reports of Bedfordshire lower schools
A very simple presentation displaying the standardised scores of the Key Stage 1 mathematics, reading and writing results of 134 Bedfordshire lower schools recorded in pre-2004 Ofsted reports. The profile clearly shows that the scores in the three areas are related.
Appendix C: Analysis of PIPS data
<table>
<thead>
<tr>
<th>Category</th>
<th>Abb.</th>
<th>Sub-category</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbolism</td>
<td>l</td>
<td>lexical</td>
<td>The written word</td>
<td>How much does the cheapest pizza cost?</td>
</tr>
<tr>
<td></td>
<td>m</td>
<td>mathematical</td>
<td>Symbols used in mathematics that are neither numerical or operational</td>
<td>£, =, &lt;</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>numerical</td>
<td>A number written as a symbol</td>
<td>12, 6</td>
</tr>
<tr>
<td></td>
<td>o</td>
<td>operational</td>
<td>Indicating a mathematical operation</td>
<td>+, ±</td>
</tr>
<tr>
<td></td>
<td>in</td>
<td>informative</td>
<td>Informing the pupil to indicate a response in a particular way.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>pictorial</td>
<td>Represented as a picture</td>
<td></td>
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<tr>
<td>Representations</td>
<td>t</td>
<td>tabular</td>
<td>Numbers presented in a table</td>
<td>pizza price list</td>
</tr>
<tr>
<td></td>
<td>g</td>
<td>graphical</td>
<td>Numbers represented as bars, blocks, segments or co-ordinates</td>
<td>bar charts</td>
</tr>
<tr>
<td></td>
<td>is</td>
<td>irregular shapes</td>
<td>Any shape that is not regular</td>
<td></td>
</tr>
<tr>
<td></td>
<td>rs</td>
<td>regular shapes</td>
<td>A shape that has some degree of uniformity and has been given a particular mathematical name</td>
<td>Square, circle, pentagon</td>
</tr>
<tr>
<td>Syntax</td>
<td>swE</td>
<td>written English</td>
<td>Words written in an recognised order to give meaning</td>
<td>Look at this pattern. Pattern this at look does not make sense.</td>
</tr>
<tr>
<td></td>
<td>sm</td>
<td>mathematical</td>
<td>Numbers written in a recognised order to give meaning</td>
<td>7 + 3 = 10. 10 7 3 = + does not make sense.</td>
</tr>
<tr>
<td>Others</td>
<td>la</td>
<td>lexical</td>
<td>A letter or series of letters that represent a longer word</td>
<td>p for pence</td>
</tr>
</tbody>
</table>

Elements in presentations of PIPS mathematics assessment units
| Assessment unit 1 | in | l | p | swE | I | Ex | MA |
| Assessment unit 2 | l | n | swE | Q | Ex | IA |
| Assessment unit 3 | n | o | smE | Im | IA |
| Assessment unit 4 | l | n | p | swE | IQ | Ex | IA |
| Assessment unit 5 | n | o | sm | Im | IA |
| Assessment unit 6 | n | o | sm | Im | IA |
| Assessment unit 7 | n | o | sm | Im | IA |
| Assessment unit 8 | l | n | o | p | sm | swE | Q | Ex | IA |
| Assessment unit 9 | l | n | o | p | sm | swE | Q | Ex | IA |
| Assessment unit 10 | in | l | n | rs | swE | l | Ex | MA |
| Assessment unit 11 | l | n | swE | Q | Ex | IA |
| Assessment unit 12 | l | n | swE | Q | Ex | IA |
| Assessment unit 13 | l | n | swE | Q | Ex | IA |
| Assessment unit 14 | a | l | n | p | swE | Q | Ex | IA |
| Assessment unit 15 | l | n | o | p | sm | swE | Q | Ex | IA |
| Assessment unit 16 | g | l | n | swE | SQ | Ex | MA |
| Assessment unit 17 | g | l | n | swE | SQ | Ex | MA |
| Assessment unit 18 | g | l | n | swE | SQ | Ex | MA |
| Assessment unit 19 | a | l | n | p | swE | Q | Ex | IA |
| Assessment unit 20 | l | n | swE | Q | Ex | IA |
| Assessment unit 21 | l | n | swE | Q | Ex | IA |
| Assessment unit 22 | l | n | swE | Q | Ex | IA |
| Assessment unit 23 | n | o | sm | Im | IA |
| Assessment unit 24 | l | n | swE | Q | Ex | MA |
| Assessment unit 25 | ir | l | o | swE | Q | Ex | MA |
| Assessment unit 26 | a | l | n | swE | Q | Ex | MA |
| Assessment unit 27 | l | n | swE | Q | Ex | MA |
| Assessment unit 28 | l | rs | swE | Q | Ex | IA |
| Assessment unit 29 | l | n | swE | Q | Ex | MA |
| Assessment unit 30 | l | n | o | sm | swE | Q | Ex | MA |
| Assessment unit 31 | l | n | swE | SQ | Ex | MA |
| Assessment unit 32 | l | p | swE | IQ | Ex | MA |
| Assessment unit 33 | l | swE | I | Ex | IA |
| Assessment unit 34 | l | rs | swE | Q | Ex | MA |
| Assessment unit 35 | l | m | n | t | swE | SQ | Ex | IA |
| Assessment unit 36 | l | m | n | t | swE | SQ | Ex | IA |
| Assessment unit 37 | l | m | n | t | swE | SQ | Ex | IA |
| Assessment unit 38 | l | m | n | t | swE | SQ | Ex | IA |

Analysis of individual assessment units
<table>
<thead>
<tr>
<th>Type</th>
<th>Description and example</th>
<th>Assessment Unit</th>
</tr>
</thead>
</table>
| 1    | Posed in words and numbers written as symbols.  
*What is 10 shared between 2?* | 2, 11, 12, 13, 20, 21, 22, 24, 27, 29, 31 |
| 2    | Posed in numerical and operational symbols.  
4 + 11 = | 3, 5, 6, 7, 23 |
| 3    | Involved inserting a number in place of a star.  
3 + * = 9 | 8, 9, 15 |
| 4    | Adding up money. Coins were drawn and the value written underneath in the form, for example, 5p | 14, 19 |
| 5    | Interpreting a bar chart.  
How many cars did Ruth count altogether? | 16, 17, 18 |
| 6    | Identifying or counting mathematical shapes.  
Which shape is the pentagon? | 28, 34 |
| 7    | Interpreting a table.  
How much does the most expensive pizza cost? | 35, 36, 37, 38 |
| 8    | Could not be placed with any other assessment unit to make distinct type. | 1, 4, 10, 25, 26, 30, 32, 33 |

*Presentation types*
Appendix D: Sample of field notes
6 November 2006

The first recording session. I feel well-prepared and that the school are on my side. I know Teacher A will be nervous. As well as being a governor I have also taught her. On the other hand I have always been accessible when she need a shoulder to cry on so I know she feels she can trust me. She’s also nervous about the interview so I’ve said I’ll have the camera filming me for CPD purposes. She was happy with that. I’ll have a few minutes of chit-chat before the interview so that she becomes accustomed to the situation.

Class 1.

Pre-research day questions:

Q1- like a foreign language. Has to be learnt and related to maths. Words like together, equals. You have to learn methods to get to answers.

Q2- huge. You do everything verbally. The practicalities of everyday...language reinforces it.

Context

08:00 Rob and I arrive to set up. Rob has pulled a muscle in his leg and is moving really badly. I feel I should say let’s leave it for today but too many people are expecting this to happen. He say’s not to worry and that his wife will becoming soon to help carry put the equipment into place. Must buy her some flowers, and Rob some wine as a sign of my appreciation for him soldiering on.

Rob’s recording equipment in the lobby. Small cameras X 3 attached with bluetack to shelves, hidden in doll’s house. Microphone in doll’s house, in a bag around a teddy’s neck, also with cameras.


08:30 Teacher looks good, hair styled, in brown overall, smiley despite not sleeping the previous night. I feel bad about that, putting her through this upset. On the other hand she is eager to show what her children can do. Welcoming. Made the classroom come alive. Says she’s nervous but doesn’t show it.

09:00 Parents arrive. No-one wants extra information about the research. Activities set out. Number jigsaw puzzles. Laminated elephants coloured by children with numerals/paper/pencils for children to practice writing symbols. Computer on with programme all about number. Door open so cold- see classroom climate continuums. One mum stays on and completes a puzzle with a group of children, counting 1-5. Teacher encouraging. Child Cg tells T1 ‘My brother hurt me.’ Child Cg on computersound, visuals, kinesthetics. Child Db arrives, says ‘Hello Mrs Raiker!’ Goes to see what Rob is doing. Parent talks to Rob. Child Db quickly looses interest. Joined Child
Cg at the computer. Count together ‘1-2-3’. Child Fg arrives, smiling. Child Db now writing numbers. Other children arrive. School secretary comes in with paperwork. T1 talking to children, parents, smiling, welcoming. Sound on computer loud. ‘Well done!’ You’re a star!’ and lots of cheering. Positive reinforcement. No-one seems to bother. From jigsaw table... ‘What number comes after 2?’ from T1: ‘1, 2,...3!’ Child Bg. T1 ‘You’re a superstar!’ Chil Bg smiles. All but Child Cg (on computer) around jigsaws. Child Db counting 1-5. T pointing for Child Bg the number 6 (hasn’t achieved 1-1 association yet). Liz 1-2-3-4-5-6...’ Child Db says 7. T1 - which one is ?? Child Db points. T1- very clever young man. Knock on the door. Child Ag-I have something to tell you. I have a baby sister, Jasmin. Children Bg and Db counting 1-10. All children smiling, friendly, welcoming. Child Db tidies up on T1’s request. All number work teacher-generated apart from that by the computer software.

09:20
T1 sits cross-legged on floor in front of IA/WB. Space tight but T1 likes it. Called it cozy. Rob adjusting cameras. Children unconcerned. Sun streaming through window, T1 closes blind.

Recording starts.

Recording ends 10:20

Seating for teacher input

Ag

T1

Fg

Bg

Cg

Db

Eg

Key words- behind, on, top, over, around, in, side, in front, behind

Hated seeing herself but quite happy to talk to the camera when it was focussed on her voice and not her face.

Had to force herself to come back into the classroom to see the recording, for the children’s sake. She said me being in the classroom was reassuring. Otherwise it would have been just her and the cameras and she would not have liked that. Mustn’t under-estimate the effect the filming is having/might have on the teachers/teaching assistants. Children didn’t seem concerned at all.
Appendix E: School Self Evaluation Form 2006 marked up
LOWER SCHOOL X

SCHOOL EVALUATION FORM
CHARACTERISTICS OF OUR SCHOOL

1a. Attainment on entry

- Our current reception year is a very small cohort of 8 children (Nov-06). We have admitted 5 new children this term, 3 older reception children have benefited from two further additional terms in the reception class. This has impacted on their personal development, their communication and literacy and their mathematical development (FS Profile).

- Pre-school experiences vary. In this cohort 2006-7 the percentage of children not attending pre-school is 42% (Admission data) This is affecting standards on entry, particularly in PSED and in speaking and listening (Baseline data).

- Links with pre-school settings are not well developed, for most parents X has not been their first choice of lower school. This makes admission numbers difficult to predict and induction arrangements can not be planned in advance. (Admission File)

- Attainment on entry is generally below the levels expected for children of this age. Particular weaknesses are personal and social development, speaking and listening and mathematical development. (Baseline data)

1. There is a lack of secure evidence to support assessment on entry judgements in previous years this makes year on comparisons difficult. Baseline assessment linked to FS Profile introduced 2006 (Assessment File)

- We have revised our procedures for assessing attainment on entry to ensure that we have a more accurate baseline from which to monitor achievement throughout the year. We use the FS stepping stones and ELG criteria to support these judgements and make records on the FS profile. (Assessment data, FS Profile) This is used to monitor achievement throughout the year.

- We assess children when they first start school in a range of ways; through home visits, through planned activities, by contacting other settings, if relevant, and by talking and observing children. (Assessment data, individual files)

- We use information from outside agencies to support children and parents and to plan for individual needs. Our Learning Mentor plays a crucial role in this. (IEP's, LM File, SEN File)

1a Social and Economic Background

- The school has 42 children aged 4 plus to 9 years of age. (November 2006) The standard admission number is 15, at present we are well below this.

- Our percentage of Free School Meals in November 2006 is 7% this is very similar to last year when it was 8%.

- During 2005-6 13% of our school population joined in year groups other than FS. This year 2006-7 we have already admitted an additional 14% of our total population since September (Nov-06).

- Children come from a range of socio-economic backgrounds; 20% from Xvillage, 46% from Shortstown, 28% from Bedford and 5% from other villages (Admission File).

- 1 child has a statement of special needs and another is currently in the process of statutory assessment. 12% are at School Action Level.

- All children identified with special needs have IEP's which identify their need and which targets support (SEN File) This is currently an area of focus (SEN Action Plan).

- Children receive support from other adults, from differentiated work and from individual resources. We also act on advice from outside agencies (planning files, IEP's).

- The number of British White is 89.7% (2005 PANDA) with the next highest percentage of children any other white background 5.1%.

- There is presently 1 child in the school with EAL.

- The school level of attendance for 2005/6 was 93.7% and we just failed to meet our LA target of 94%. This was an improvement from 2004/5 which was 91.8%. This poor attendance has been due to a small number of families who have complex needs. We have introduced a series of rewards to ensure that we meet our 2008/7 target of 94.5%. Unauthorised absence was 0.4%.

1b. Distinctive aims and Special features

- The current aims and value statements do not reflect the views of our current staff and governors. (School Prospectus) The new head and governors have identified this as a priority for action (January Inset 2007).

- Children start school in the academic year in which they are 4, there are currently three intakes per year. (School Prospectus) There are no facilities for pre-school experiences and children benefit from attending for two additional terms (FS Profile).

- The school roll has declined over the last three years due to lack of pre-school provision at the school and a poor reputation within the local community (Admission Data) The roll
is beginning to improve 2006-7 with 7 new children being admitted since September 06 (Admissions)

- Children transfer to a number of middle schools including Abbey, Harrowden, and Robert Bloomfield. (LM file)
- Transfer and transition arrangements are good because there is good emphasis on this within our learning community. Our Learning Mentor arranges visits, attends liaison meetings and works alongside other Learning Mentors to ensure continuity for individual and vulnerable children. (LM File)
- The current School Improvement Plan is a continuation of the areas identified by the previous federated head. Progress has been reviewed and planned action adapted to meet the current needs of the school. The current foci are to raise standards, work towards a 'Healthy Schools' accreditation, improve provision for ICT and PE, continue to improve behaviour and attendance and provision for SEN (SIP)
- The school is part of a large Learning Community (36 schools, cross phase – nursery to upper). We are part of the Excellence Cluster and benefit from a 0.5 Learning Mentor (job description file). There is a detailed programme for training and support but this is not always appropriate or accessible for very small schools like ourselves.
- We take work experience pupils from a range of local upper schools, this supports learning for our children
- The school prospectus requires updating to reflect the current school situation. (To be addressed by new head teacher 2007)
- The school offers violin lessons for pupils from Year 3 (2 pupils currently in year 3)
- Italian is taught at Key stages 1 and 2. (Timetable)
- After School provision is available for a maximum of 16 children, it is funded by a grant for rural communities. 31% of children use this facility on a regular basis.
- Community links are developing. (Invitations to school activities, links with the church, growing links with the village play group)
- There is an active PTA. The money raised is used to subsidise whole school visits and visitors.

1c. Aids to raising standards

- This is a small, friendly and very caring school, approachable and committed staff
- Small class sizes allow for individual and small group attention
- Good focus on differentiated teaching (Planning Files)
- There is effective use of Teaching Assistants to target individuals and small groups to raise standards (Timetables)
- The Learning Mentor provides support for individual children to remove barriers to learning and to raise standards (LM File)
- Weekly celebration assemblies motivates children and informs parents of learning in school (Timetables)
- The school has appointed a permanent senior teacher (started September 2006) and a permanent head teacher (starting January 2007). This will bring long awaited stability to the school. This will be the sixth head teacher in five years.
- Enthusiastic and committed governing body that is eager to extend their involvement and to develop their role. All Governors give generously of their time. They have reviewed their current roles / responsibilities and are beginning to plan action for future improvement (Governors minutes, Action Plans)
- There is a programme for governor visits. Each year group have ‘adopted’ a governor. (Governor File) There are plans to make these visits more focused (Governor Action Plan)
- The new ICT suite is well used to develop computer skills and to support all areas of the curriculum. We are monitoring the impact this is having on raising standards in ICT. (Timetables)
- ICT facilities have significantly improved since Jan. 2005. A Computer suite has been established in what was once the Reception Classroom. Each classroom has 6 networked computers and each class has an Interactive White board. All staff are receiving training to ensure ICT is used as an effective learning tool. (CPD File)
- The School House was modernised and refurbished in July/August 2005 and a Library established in the ICT suite. The library has enhanced learning by children having more opportunities to access books (class timetables)
- Literacy expenditure has increased with over £5,000 spent on Guided Reading Books in 2005. Books were chosen that would appeal to all readers e.g. boys, girls and for all ability ranges including challenging texts for the more able. This is having an impact on standards (KS2 Reading Tests 2005)
1c. Barriers to raising standards

- Increasing number of children come from neighbouring catchment which has a high level of social deprivation (Admission File)
- A high proportion of children have no pre-school experience (Admission details)
- Numbers are falling and it is difficult to project future intake because most local parents choose schools with pre-school provision (admission file) this affects induction.
- Very small reception class, 8 children, makes classroom dynamics difficult and aspects of PSED difficult to provide.
- Annual concerns about the budget due to falling roll, this affects the quality of resources (budget predictions) and the sustainability of the school. This has been unsettling for staff and parents, and has impacted on the number of applications for school places received by the school (Budget Predictions)
- 66% of staff are relatively inexperienced (NQT, unqualified teacher) senior teacher new to school September 2006 (Staff Profile). There is limited expertise to support curriculum development and to undertake curriculum responsibility. (Staff Profile)
- Large percentage of children with behaviour concerns 2004-6 (24%) this has impacted on their learning and has affected standards (Analysis of Test results document 2006). The number of children with behaviour concerns, September 2006, has now reduced to 7% due to natural transfer and impact of LM support and whole school understanding of expected behaviour.
- There is currently one governor vacancy. The school has worked hard to fill vacancies. There is a good range of expertise on the Governing Body, Nov 06 (Governor File)

1d. Additional characteristics

- The school has been unable to attract a permanent head teacher for several years therefore leadership and management has been unsettled. The school has had two federated heads in the last three years and staff and governors felt that it had lost its own identity. (School Evaluation)
- The current acting head teacher has been appointed for two terms. She adopted the following staffing structure at Easter 2005: unqualified teacher, graduate trainee teacher and one qualified teacher who resigned shortly into the summer term.
- The percentage of children with special educational needs is 20%. This has reduced since last year from 26%. TA support for child with statement of special need and for child for whom a statement is pending
- The school is currently working towards 'Healthy School status' focusing on the four areas of physical health, emotional health and well being, personal and social health and healthy eating. This will contribute to the principles encapsulated in the Every Child Matters agenda.

1e. SDP Priorities

- Assessment: Understanding of strengths/weaknesses, use of APS to measure achievement, target setting, extend use of 'Aspire' to monitor progress, moderation to ensure whole school understanding. (Improved understanding by all staff will help us to identify strengths and weaknesses and to monitor more accurately the achievement made by all children)
- PE: Improve quality of teaching, improve resources for gymnastics and dance (contributes towards HS Status)
- Behaviour and attendance (contributes to HS Status, supports key issues in 1c and 1b)
- Continue to raise standards in ICT, training for all staff, better use of ICT as a tool for teaching and learning (supports evaluation in section 1a)
- To improve standards in mathematics' English and science: staff training, resources (supports evaluation in 1a)
- SEN/G&T: Improve provision, ensure that all children achieve as well as they can, training for new co-ordinator (supports priorities in 1a, 1c, 1d)
- FS: Improve assessment, planning and resources (supports evaluations in section 1a)

Comment: SDP priority to improve standards in maths and English

2a Views of learners, parents/carers and other stakeholders

Information and views of learners, parents/carers and other stakeholders is gathered in a range of ways:

- We seek parent's views through; annual questionnaires, informal discussions and feedback about school events, through 'open door' policy which encourages parents to share their views about the school. Planned meetings seek parents views - issues are fed into SIP, planned action (School Improvement File, SIP)
Children's views are sought through: school council, annual questionnaire, PSHE sessions, planned assembly topics. (Assembly File, School Council minutes, PSHE plans, lesson evaluations)

Opportunities to listen to parents expectations during home visits for new entrants.

Children with special educational needs and their parents contribute to IEP's, good ongoing dialogue is maintained (SEN File)

Half termly information relating to curriculum provision for each class is sent home.

Each class has a parent's information board. (Newsletters, Class displays)

Three consultation evenings a year, plus written information for parents with regard to how well children are progressing. Attendance at these has improved enormously (90% approximately). During the year parents are given written information about what their child learning and how parents can support their children's learning. These are well received.

Homework and reading diaries allow for a two way dialogue (Homework books)

Planned visits by all governors to visit school, to allow for better understanding about the quality of teaching, standards and the ethos of the school. (Minutes of Governors meeting 25.9.05). Planned observation criteria to be devised to contribute to whole school improvement (Governors Action Plan)

Governors provide feedback about the work of the school in committee meetings, through questions, discussions (Minutes of meetings)

Curriculum events and whole school themed days are well supported by children and parents (Parents / children's Views)

PTA meet regularly, good opportunity for parents and staff to work together. Parents are enthusiastic and money raised subsidises the cost of visits and visitors (minutes of PTA)

Year 4 children have decided their school responsibilities for this year and wear their badges with pride (Discussions with children, observations)

We have some confident children who enjoy the opportunity to take on responsibility such as monitors for the office, for the library and playground. The School Council meets regularly to seek and share views of other children (School Council Minutes)

Any complaints are dealt with effectively and efficiently (no formal complaints since January 2005) This is because we are committed to building positive relationships with all our parents and communicate regularly through meetings, newsletters etc (Complaints Record)

Staff are committed to working in partnership with parents. Parents of reception children are invited to take their children into school and 'work' with them for the first twenty minutes. This helps children to settle, to share their learning with their parents and encourages parents to step inside the learning environment to see what's going on. This results in more parents supporting the school both in terms of their children's work and in extra curricular activities. (good attendance at fetes, community events)

New senior teacher is introducing 'conferencing with children in years 3 and 4. (Assessment File)

2b Information about the learners standards, personal development and well-being, and the quality of your provision.

Children mostly enjoy being at school and finding out new things in lessons. Survey outcomes and discussions show:

- They know they can get help if they are stuck
- They are confident that adults will support them if they are worried and they think teachers are fair.
- They think that they work hard at school and that teachers help them to improve their work. (Views of Learners, Parents/carers and other stakeholders)
- Parents say that their children settle well into school and are happy (Parent Consultation evenings, informal discussions)
- Clear homework timetable, parents involved in their children's learning
- Lunch breaks have much improved this term, a range of equipment encourages cooperative play (Observations)
- Pupils enjoy opportunities for visits and visitors linked to class and whole school themes
- Parents feel informed about standards in reading, English and mathematics (reading diaries and homework books)
- School Council seeks the views of others through surveys and PSHE sessions, to gain ideas with regard to improving some areas of school life such as playtimes, equipment and responsibilities.
- Our weekly 'Gold Star Assemblies' are very well attended and enjoyed by children and parents.

Comment: Parental knowledge about standards in maths. Are they happy??
2c Sharing Information

- There is regular correspondence with parents; open door policy, HT maintains high visibility before and after school, Friday morning coffee mornings, regular letters and newsletters
- Information from collated questionnaires is shared with parents once an analysis has been carried out (90% return gained by asking for completion during consultation evening 2005/06)
- Parents receive curricular information and timetables each half term and are fully informed about the intended learning planned for PPA time.
- Children's annual reports give parents clear information about their individual strengths and areas for improvement. There are targets for future learning in each of the core subjects and in ICT
- School Profile informs parents about the schools' achievements and areas for further improvement
- Weekly school assemblies provide opportunities for each class to show parents something that they have learned during the week. This also informs all children about the learning that has taken place in other classes
- PTA correspondence, meetings/letters
- School Council share information and seek views from all children (Minutes)

2d Examples of actions taken as a result of surveying others views

- We have introduced a range of activities for children to enjoy at lunchtimes (Timetable)
- Introduced a programme of homework for key stages 1 and 2. Parents involved in their child's learning, parents contribute well to reading diaries
- Introduced new playground markings and put more staff out at playtime to improve the quality of play. This is supporting PSHCE development, children show more consideration for one another, children from all age groups play together. Children show good tolerance to one another. As a result, children say that they enjoy playtimes (Discussion)
- Planned more curriculum theme days for whole school involvement (Curriculum File)
- Action taken to improve consultation evenings by giving parents time to view their children's work before meeting the teacher. This has led to more informed discussions and understanding of targets.
- Pupils' wanted 'discos' after school, this is now provided each term.
- Parents were concerned that there had been too many changes in staffing. We now have a permanent staff and a new head teacher who will commence duties in January 2007

Achievements and Standards

3a. Learners achievements and standards. Please refer to Assessment and Standards File 2006.

1. In 2006 KS1 task results 80% children achieved L2 in mathematics, in writing and in reading. We raised the standards achieved by lower attaining children, (no W in any subject) but no children achieved level 3. Points to consider:
   - Very small cohort (5 children) makes year on comparisons difficult
   - Staff changes throughout year, inexperienced staff
   - One child has a statement of special need
   - One child joined at the beginning of Y2
   - Results show standards to be highest in mathematics (very slightly) and lowest in writing, but such very small cohort makes secure analysis difficult.
   - No L3's, need to target higher attaining children, provide additional challenge / differentiated tasks / higher expectations

2. 2006 KS1 point score for reading 13.8 (17.4), writing 13 (17.2) and mathematics 13.4 (17.2). 2005 in brackets. The school falls below national results in all three subjects

3. There are no significant differences in attainment between boys and girls

4. In reading and writing most children do not meet their targets, in mathematics most children met their targets. Need to focus more carefully on target setting, use of tracking programmes to support understanding. (see school improvement; assessment plans)

- Year 4 QCA for 2006 shows results to be below targets set in school and below those of previous years. Only 27% achieved level 3 or above. 72% did not make the expected
progress of 6 points from KS1. 63% did not achieve their targets. APS were well below those expected at 15.85, LA target was 21.3. Explanations are as follows:

1. Class teacher's first experience of teaching in KS2, lack of subject knowledge (teacher left July 2006)
2. Insufficient challenge for HA, planning for different ability groups was an issue in this class (SIP priority)
3. Assessment and monitoring of achievement were not sufficiently well understood or used to target individuals and to improve standards (SIP priority to develop more secure tracking and targeting of children's attainment levels)
4. Problem solving and calculations are areas of particular weaknesses (SIP priority)

- 45% identified with SEN, 36% receiving support for emotional and behaviour concerns
- 27% poor attendance, EWO involvement (SIP priority)
- Children performed best in reading 54% achieved L3 or above, the school and LA target was met. 36% achieved L4, 63% made or exceeded the progress expected from KS1, 18% did not make progress expected, and 18% joined in years 3 and 4. APS 19.73 (below average)
- In writing 90% met or exceeded their targets, 36% exceeded levels expected (were targets set sufficiently high?) APS 19, higher results than in previous years but still below average. spelling, punctuation are weaknesses (SIP priority)
- Progress from year 2 to year 4 2004 to 2006 shows 6.22 in reading, 7.77 in writing and 4.66 in Maths.
- Small cohort (11 children) makes year on comparisons difficult
- There are no noticeable differences in attainment from different groups (Tracking File)

3b. Achievements in the Foundation Stage

- It is difficult to judge the progress children make in their reception year because base line assessments have not been recorded or matched to FS curriculum in previous years
- A baseline assessment has been introduced from September 06 and findings recorded on FS Profile. This now provides a clear picture of strengths and weaknesses (Baseline Data)
- Assessments at the end of FS vary from year to year because cohorts are very small (Assessment File)
- PSE, CLL and MD are particular weaknesses. Most children in the present cohort have not attended other settings before their reception year. (Assessment File)
- Improved assessment procedures provides valuable information which is used to plan for children's further learning (Assessment File, Planning)
- The foundation Stage has been the focus for improvement since April 06. Improved resources, review/revised planning and assessment, re-organised learning environment, better use made of outdoor area for developing physical skills (School Evaluation/Planning File)
- The school results for the Foundation Stage have fallen significantly this year from being the highest to the lowest in the LC and LA. This is due to staff experience, very small cohorts, SEN concerns, EAL and poor attendance. The school now feels that the current assessments are a more accurate record of the children's attainment in 2005-06

3c. Key priorities (Refer to SIP 2006)

Our main priorities this year are:
1. Improve standards in mathematics; calculations and problem solving and in writing; spelling, punctuation and grammar and in reading. This will be done by:
   - Improving resources, re-organising reading scheme
   - Revising timetables to allow for dedicated teaching time
   - Introducing home work to support learning in class
   - Introducing booster classes to target individuals and small groups
   - Introducing lunchtime clubs practice mathematical skills and spelling strategies through games
2. To improve assessment, introducing individual targets, conferencing and to improve our understanding of data and tracking procedures to inform planning and to target individuals
3. To work towards 'Healthy School Status' continuing our work in PSHE, and physical development
4. To continue to improve standards in ICT, this work is supported by AST and to make better use of interactive whiteboards as a tool for teaching and learning
5. To improve provision for SEN and G&T
4. PERSONAL DEVELOPMENT AND WELL-BEING
Provision for personal development and well-being is satisfactory overall with some good features.

4a. Learners healthy lifestyle
1. The provision for PE is improving. (School Evaluation File, Timetables, PE File)
   - The school now provides 2 hours of PE each week
   - Better use of outdoor area has improved provision for reception children
   - The school is benefitting from its links with Biddenden Sports College; advice/support for staff, developing the role of the co-ordinator, support from other lower schools by sharing good practice
   - Vulnerable children are targeted for football training (Nov-06) it is too soon to see the impact of this on their personal development
   - Improved resources for games, dance and gymnastics need further improvement
   - Speed stacks introduced at lunchtimes
   - Children take part in a range of competitive sports against other schools
   - Further improvements planned in SIP

2. We aim to promote healthier food and drink options by providing fruit at break times. (Government initiative), milk for reception children, water for children throughout the day. Visit from ASDA to promote fruit through tasting sessions
   There are plans to improve this further refer to Healthy School Status Self Review (SIP)
3. There are a range of outdoor activities for children at lunchtimes and play times, this now needs to be used more effectively by staff. New playground markings are enjoyed by most children, supports their personal development
4. Classroom aerobics introduced, this re-focuses children and helps to stimulate further learning (Lesson plans)
5. Keeping Safe Day Oct-06 focussed on road safety, keeping visible and planning safe routes to school (the school is alongside a very busy road) (Curriculum Plans)
6. Life Education Bus visits annually, this is planned into our curriculum

4b. Learners safety and adopting safe practices
The school is good at ensuring our learners are safe by adopting safe practices. This is carried out through:
1. The appointment of a Learning mentor who plays a crucial role in identifying and supporting individuals. Children understand this role and all feel that they have some-one to talk to. This role is also clearly understood by parents who often share their worries or concerns (LM File)
2. Clear system for identifying vulnerable children as well as those who are potential bullies. There is targeted support which is having an impact on the standards of behaviour in school and at playtimes. (LM File)
3. Behaviour has greatly improved since September 06 because: disruptive children in year 4 left, more staff stability and consistent approaches to dealing with behaviour and support from Learning Mentor (Observations Evaluations)
4. School Council has been re-launched and children play an active role in helping to promote good behaviour at playtimes (Monitors, Minutes)
5. Good emphasis on PSHE allows children to identify and discuss expected behaviour. Circie time and assembly time encourages children to share their likes and dislikes about school and identify future improvements, this gives children ownership of their school and is helping the whole school to share in the same ethos and values. (Assembly topics, PSHE programmes of work)
6. Playtime buddies take their roles seriously and help children to feel safe at playtimes (Observations, discussions with other children)
7. Good procedures at the end of day ensure that children are passed on individually to parents, children are very familiar with these procedures (Prospectus)
8. There are good links with school nurse and Educational Welfare Officer this advice has helped us to improve attendance and to improve our support for some families causing concern (Attendance File)
9. Regular training which is shared with all staff to ensure whole school consistency (CPD File)
10. We have a range of Policies and procedures in place to ensure the safety of our children, these now need to be re-introduced to ensure full understanding by all staff (Nov-06) See Policy File

4c Learners enjoyment of education
- Children tell us they enjoy coming to school, they particularly enjoy, school visits, visitors Theme Days and taking part in PE. (Whole school discussions)
- Children respond particularly well to the interactive whiteboards, this sustains interest and motivates children in all subjects (Lesson Evaluations, Lesson observations) As a result children make positive contributions in lessons and are keen to use the interactive board during demonstrations
- Attendance is improving because we award a cup each week for the best class and reward the best year groups at the end of each half term. We monitor absences carefully and follow up concerns. We still have some families whose attendance is of concern, these are being constantly monitored. (Attendance File)
- Each class decides their own rules which are prominently displayed. As a result all children know and understand the behaviour expected within their classrooms (Observations, displays)
- Year 4 children told us that they wanted to be given more responsibility within school. We now have monitors for a range of jobs. This is developing self esteem, and making children feel more valued within school (Observation of behaviour, discussion with children)
- Gold Star Assembly is an opportunity for children to show parents what they have learned during the week and for the whole school community to celebrate children's achievement. This is proving a good incentive for children who receive awards for a range of reasons. This is well attended by parents.
- We arrange for children to have a range of visits and visitors to enrich their curriculum and to make learning fun. These have included, artists, musicians, theatre groups, and Librarians to read stories. Children also enjoy educational visits and are particularly benefiting from contact with children from other schools. Some vulnerable year 4 children have been especially chosen to perform a play with children from other schools about bullying. Their self esteem, confidence and social skills are being greatly improved through this exercise. (Learning Mentor File)
- The school places emphasis on providing a learning environment that is stimulating and one which values children's efforts. We take care to display a range of work so that each child can take pride in their achievements. (School Environment)

4d. Learners contribution to the community
We are a very small village school our children contribute to the school and village in a range of ways:
- School Open days where we invite the whole village to visit our school
- Good liaison with the Police Liaison Officer, regularly accessible to children, staff and parents
- Links with the Baptist Church, Harvest and Christmas Celebrations, visits as part of RE and history
- The school is open to the community for Macmillan Coffee mornings, Celebration Assemblies, concerts and annual BBQ
- Invitations to attend Harvest and Christmas concerts
- Children support a range of Charities throughout the year, Christmas Shoe Box Appeal, Anti-bullying. These are instigated through church links, School Council and from school concerns
- There are opportunities for children to act as ambassadors for our school (sport, educational visits, Assemblies, in Church, to school visitors) Through these experiences children are learning about citizenship and expected behaviour (School Profile, Curriculum plans)
- We monitor children's participation in a range of activities to ensure that there is equality of opportunity for all (small staff allows for regular consultation, children are selected for a range of reasons e.g. low self esteem, confidence, as a reward etc. Children are aware that everyone is equal ( PSHE, discussion groups)
- HT and Staff visit local playgroup to build relationships, this requires further development
4e. Learners preparation for their future economic well-being

- Priority is placed on improving standards in English and mathematics to help all children to be prepared for the next stage in their learning (Standards and Tracking)
- Homework has been developed in KS1 and 2 to involve parents in our drive to raise standards (Timetable)
- All children undertake classroom responsibilities, older children in year 4 undertake whole school responsibilities to give them a higher profile in school. As a result older children are developing a sense of pride and feel that they are valued, they are also aware that they are role models for younger children (discussion with children, reasons for wanting responsibilities)
- There are a range of opportunities for children to engage in team work, within class during lessons, as members of school council, in sporting teams, in PE, as year groups. Children have made good progress in their ability to work as a member of a team, this is because of the range of opportunities and because all staff have agreed behaviour expectations (Behaviour Policy)
- Children have weekly opportunities to perform in front of others in Gold Star Assembly. This is boosting the confidence of all children. (Observations)
- Older children take responsibility for helping to run the tuck shop. This is developing their mathematical skills
- Weekly opportunities for older and younger children to read together develops personal skills such as patience, respect and tolerance of one another (Behaviour improvement, Observations)
- We encourage work experience students from local schools, they share their expectations with our children and set good role models for our year 4's

4f Personal, social and well-being in the Foundation Stage

The provision for PSED in the Foundation Stage is satisfactory overall. Children start in reception with personal and social skills well below the levels expected for children of this age.

- Induction allows for home visits, school visits and individual discussions with parents, this helps us to get to know children and parents before they start school. (Admission procedures)
- Staggered intake allows children to settle gradually, parents stay for as long as is required, the school meets the needs of each individual child (very small intake allows for this)
- Parents are welcomed into class each morning to settle their children and to remain with them for the first 20 minutes. This informs parents of the learning that is taking place and makes the act of separation much easier (Timetables)
- The curriculum is well planned to provide children with opportunities to experience a wealth of new experiences. This helps children to become motivated and more adventurous (FS Planning File)
- FS children take a full and active part in school life (Refer to sections 4a,b,c,d,e)
- PSED is a weakness for most children when they start school, because of lack of pre school experiences. The school is developing its assessment practices and is now using this information to target and to plan for individual needs (Refer to SIP)
- The school uses SEAL materials to develop children's personal and emotional skills. As a result children start to develop an awareness of their own needs and those of others. (Planning File, Assessment, SIP)
- There are good opportunities for reception children to work with children in year 1. This aids transition for year 1 children and allows for shared planning between the two year groups. (Planning Files, Lesson evaluations)
- Developing respect for other culture is a focus for reception. Children have just celebrated Diwali which culminated with a whole day of activities; making and tasting food rangoli hand patterns and dressing up. (Nov-06)

4g on the basis of your evaluation, what are your key priorities for development?
Our main priorities are:
- Plan SEAL materials across the school to ensure continuity and progression
- To review and revise PSHE policy to ensure whole staff understanding
- To involve all children in setting individual targets for PSHE
- To provide further training for lunchtime supervisors and re-launch a programme of activities
- To extend our use of outside agencies to support teaching and learning
- To introduce workshops for parents to make them aware of what we are doing and how they can support us at home and to seek their views
- To continue to improve outdoor play for reception children, long term goal is to provide a partially covered area for ongoing use

We have plans to improve our provision further, please refer to Healthy School Status Action Plan

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5 THE QUALITY OF PROVISION

5a How good is the quality of teaching and learning?

Overall the quality of teaching and learning is satisfactory, but the school is working very hard to improve its provision and there is evidence of good elements throughout the school. The school has suffered from unsettled staffing in recent years and this has affected the progress made by year 4 children in the last academic year, 2005-06. The predicted targets for this year (2006-07) in reading, writing and mathematics are higher than in previous years, we expect more children to achieve level 3 and level 4 in years 2 and 4.

This is a result of:
- More stable staffing structure; new appointment of senior teacher in KS2 and NQT in KS1. Our unqualified teacher in reception is gaining experience
- Planning being monitored half termly and fed back to staff; weekly plans are randomly checked to ensure evaluations inform teaching and learning
- Shared PPA time allows staff to plan and evaluate learning together
- Revised planning for foundation subjects allows for links with other subjects and for meeting ECC agenda (Planning File)
- Emphasis being placed on providing a stimulating environment that supports learning and values children's work. As a result children are proud of their school and take pride in their work (discussions during assembly and PSHE)
- Teaching being regularly observed by HT and SIA. This is fed back to staff with areas for improvement. (Lesson observations)
- Better use of performance data to analyse pupil achievement and to set realistic targets for future learning (Tracking File)
- Whole school agreement and moderation activities ensure consistency (Refer to SIP, Staff meeting minutes, Assessment File)
- Introduction of homework to reinforce learning and to encourage parents involvement
- Introduction of lunchtime clubs to practise maths and English through games
- Children have individual targets for English, mathematics and for their personal development
- CPD is planned to meet the needs of individual teachers and those identified in the SIP.

Monitoring of teaching, analysing plans and children's work shows that we are making progress in all classes:
1. By providing different tasks for children to ensure needs are being met
2. By sharing learning intentions and success criteria and involving children in assessing their own learning
3. By deploying Teaching Assistants to support children with special needs
4. By using the interactive whiteboards to stimulate learning
5. By showing that we have high expectations by providing, differentiated tasks, extension activities and by sharing success criteria for lessons
6. By marking work consistently and by identifying targets for future learning
7. By having high standards of behaviour so that all children know and understand the standards expected
8. By revising timetables to allow time to develop speaking and listening skills, handwriting and reading

Comment: Not evident during observation visits but could happen at other times.
Comment: In the forecast and tracking system. Children don't know their individual targets in maths.

Comment: LI yes but SC and 5A not observed.
Comment: Observed in maths
Comment: Observed in
Class 1
Comment: DTs, yes, Xian activities in Class 3 but inappropriate, SC shared no.
Comment: Not evident in observations

xxxviii
9. By recording on-going assessments in FS and using them to plan for next stages
10. By informing parents of work covered each half term and reporting their progress each term

5b How well do the curriculum and other activities meet the range of needs and interests of learners?

Provision for SEN is currently satisfactory with the potential to be good;
- Newly appointed SENCO is experienced and is currently improving procedures and provision throughout school for SEN and G&T (Action Plan)
- Provision for children at Action plus is good overall because teaching assistants support their learning in class. (TA evaluation books)
- The needs of all children are being met through differentiated work and from the support of our Learning Mentor (Planning Files, assessment information)
- Provision for G&T has been identified as an area to improve (see action plan)
- Governors have been very pro-active in helping to improve health and safety. (Governors Action Plan)
- Risk Assessment is in place

Provision for literacy, numeracy and ICT are good
- New ICT suite is well used (Timetables)
- Interactive whiteboards are used by all staff to stimulate learning
- ICT is the focus for development, the school is supported by an AST (Refer to SIP)
- Revised timetable allows for dedicated time for guided reading, spelling, handwriting (areas identified as weaknesses in 2006 SAT’s)
- Opportunities for children to practise mathematical skills in different contexts; tuck shop, board games
- The curriculum is broad and balanced with opportunities for children to take part in speaking and listening activities (Timetables)
- Collective worship is well planned, RE meets Locally Agreed Syllabus
- We address issues relating to bullying and racism through PSHE and through small and individual work with our Learning Mentor (LM File, PSHE programme)
- Provision for PE has improved through our links with Biddenham Sports College. The school now provides two hours of PE a week for all children. (SIP, Timetables)
- Homework has been introduced for all children in KS1 and 2. This allows children to reinforce and revise their learning in English and maths. (Homework timetable) In reception children share books at home.
- Home-School dialogue is maintained through reading diaries and individual books for some children
- There are good procedures for transition to other classes and schools and we work closely with other schools in our learning community (Transfer procedures)
- The school provides a range of lunchtime clubs which enrich the curriculum
- PPA time allows for curriculum enrichment by providing activities such as cookery, drama, gardening, dance and art and craft (Planning & evaluation)
- The role Governors play in the school has greatly improved this term (Autumn 06)
Governors correspond with children and visit regularly for a range of reasons. There is an active Teaching and Learning Committee (Governors minutes, Governors Action Plan) and Management Committee

5c How well are learners guided and supported?

The guidance and support for children is good;
- Individual targets are known and understood by children and parents
- A programme for PSHE is developing (SIP)
- The Learning Mentor plays a valuable role in identifying, supporting and monitoring vulnerable children (LM File)
- Child protection procedures are known and understood by all. All staff have received up-to-date training Nov-06
- All adults involved in school have been vetted (CRB File)
- Parents help in a range of ways, PTA, PPA time, on Theme Days, on educational visits.
- Attendance is a focus for improvement, rewards are already having an impact on this (Autumn 06) Attendance File
- Gold Star awards are used consistently throughout school and are valued by children and parents (classroom charts)
- Good opportunities for children to visit new classes or schools (LM File)
Good transition arrangements for year 1 children allow for shared learning opportunities with reception children during the autumn term.

The school works closely with a range of outside agencies to support individual children (SEN File, Vulnerable Children File).

We provide individual support for some families to ensure that they understand school procedures and policies, home visits, individual meetings, liaise with school nurse and social services and other agencies involved (LM File).

Children receive advice and guidance about their learning through: oral feedback and worked marked to the success criteria. Because we are so small parents have daily contact with staff we also provide consultation meetings each term and written reports at the end of each year (Reports, Assessment File).

The school has 2 named first aiders who regularly update their training. All Health and Safety procedures such as medicines are fully in place. (H & S policy)

Children learn about life outside school from visitors (Police, Fire Brigade, artists etc) and from educational visits.

5d. Where relevant, what is the quality of provision in the Foundation Stage, including if appropriate the quality of childcare?

The quality of provision in the Foundation Stage is satisfactory.

- The cohort is very small, 8 children, but there is no additional adult support in this class.
- The Foundation Curriculum is well planned to allow for a range of learning opportunities. (Planning File)
- The school is improving its provision in some areas of knowledge and understanding and in children's understanding of other cultures.
- The learning environment is spacious and stimulating, work is displayed with care.
- Provision for outdoor play is improving and is now starting to meet children's physical and personal needs. (Planning File)
- Assessment is the focus for improvement the school now has a clear understanding of children's attainment on entry (SIP, Assessment File).
- Very small cohort allows for good relationships with children and their families. Parents have daily access to class teacher, parents are valued.

5e Priorities for development

- To improve standards in English and maths (SIP).
- To improve educational resources for all year groups (SIP).
- To monitor the effects of initiatives in mathematics and English on standards (SIP).
- To improve use made of assessment to target individuals and to plan for different needs (SIP).
- To improve the quality of learning and teaching across the school, including differentiation and challenge for the more able.
- To improve the provision for SEN and G&T (SEN Action Plan, SIP).
- To continue to improve provision for outdoor play for the Foundation Stage.
- To provide support for parents through workshops, meetings and curriculum days.

5g grade

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<td>Quality of care, guidance</td>
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LEADERSHIP AND MANAGEMENT

6a what is the overall effectiveness and efficiency of leadership and management?

The overall effectiveness and efficiency of leadership and management is satisfactory.

- The school has recently appointed a senior teacher who is supporting the head teacher to drive the school forward.
All staff take on initiatives willingly and have played an extensive role in the development of the school. (Discussions with staff, PPA time, refer to section 4 and 5b)

The school is gradually building the capacity to tackle the issues of raising standards in English and mathematics and is focusing on target setting, accurate pupil assessment and making use of tracking procedures to effectively monitor progress (SIP)

There is a clear strategic vision for the school and there is whole school commitment. Staff work well as a team with shared understanding of the needs of the school. All staff have high expectations (Staff views, Staff meetings, school improvement)

The school is set to improve standards at the end of years 2 and 4 (Refer to section 3)

The there is clear direction for school improvement over the next few years which is known and understood by all (Staff Files, Staff meetings)

Staff meetings are planned for the term and meet SIP, school and staffing needs (Staff Meeting Plans)

Governors have a good understanding of the schools strengths and weaknesses and share and support the schools direction (Head Teachers Report, minutes of meetings)

The LA views the school as one facing temporary difficulties, due to unsettled leadership and inexperienced teaching staff in two key stages. (SIT Report) The school has appointed a permanent head teacher who will commence duties in January 07. The school is now better placed to continue improving the quality of education for all children in the school

Weaknesses are identified by analysing attainment data, observing teaching and learning, monitoring children’s work and teachers plans and through discussions with staff, parents and Governors (Refer to section 2, 3, 4 and 5)

PPA time is very effective and allows for children to work together on enrichment activities. (PPA Timetable)

Pupil Teacher ratio is good because class sizes are small (Maximum class is 18) There is additional adult support for children with SEN in KS1 and 2 (Staff timetables)

The learning Mentor is effectively deployed to support vulnerable children and those with special needs (LM File)

The school lacks resources in all curricular areas and priority is given to SIP areas. This year our focus has been on English, mathematics and the FS (SIP)

A very small budget makes meeting SIP requirements difficult (Finance File)

The governing body are very effective in meeting their statutory requirements. The chair of governors is pro-active and committees are valuable in supporting the school and helping it to move forward. (Governor Action Plans)

The head teacher and SIA carry out rigorous self evaluation through ASR (Annual School Review) and this informs the SIP (Monitoring/Evaluation File)

Delegated responsibilities are reviewed annually and linked to SIP and CPD needs.

(S School Review File)

6b. Where relevant, what are the effectiveness and efficiency of leadership and management in the Foundation Stage?

Overall the efficiency of leadership and management in the Foundation Stage is satisfactory. It is the responsibility of the head teacher to lead the FS. Day to day management is shared with the class teacher

• Improving resources has been a priority this term, but this is still an on-going concern

• There has been no clear baseline in which to judge children’s achievements. This has been now been addressed and the teacher has a clear understanding of strengths and weaknesses against FS Profile

• Improved assessment procedures are helping to identify and plan for children’s needs (Assessment File)

• Foundation Stage teacher is unqualified and is currently studying part time for a degree in education there is no additional adult support at the present time (7 children on roll)

• Standards on entry are well below in PSE, speaking and listening and in mathematical understanding. We are making progress in addressing these needs in our daily provision (Plans)

• A range of teaching techniques support learning, this is aided by new resources and interactive whiteboard There are plans to visit other settings to observe good practice (CPD File, Planning)

• There are effective daily communications with parents (School timetable, organisation)

6c. On the basis of your evaluations, what are your key priorities for development?

• Establish/develop leadership responsibilities for Senior Teacher and new Head Teacher
- Train senior leaders to use tracking programs to analyse and improve standards
- To involve teachers more in analysing performance and taking action to improve standards
- To provide staff with opportunities to undertake leadership responsibilities and provide necessary training and support
- New head teacher to develop her monitoring skills to ensure targets are met and standards are improved
- To evaluate initiatives in SIP and feedback to Governors and LA

6d Please enter grades.

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7. OVERALL EFFECTIVENESS AND EFFICIENCY

7a. What is the overall effectiveness of the provision, including any extended services, and its main strengths and weaknesses?

The overall effectiveness of the school is satisfactory
1. The school is working hard to improve the provision for all children and has made good improvement since April 2006 (School Review)
2. The school is set to improve the standards achieved last year through a range of initiatives and because provision in literacy, numeracy and ICT are good. (Refer to section 3)
3. Guidance and support for children is good (Refer to section 5c)
4. There is good attention to improving provision in all aspects of personal development and well being (Refer to section 4)
5. The quality of teaching is improving and there is evidence of good teaching across the school (Lesson monitoring)
   - Good use of interactive whiteboards to support teaching and learning
   - Improved differentiation to meet different needs
   - Better use made of TA’s to support SEN
   - Improved resources
   - Staff have a better understanding of attainment and targets to be achieved
   - Developing whole school approach to assessment, agreement and understanding
   - Home work introduced for KS1/2 for practise and consolidation of learning

6. The school offers a broad and balanced curriculum with good opportunities for curriculum enrichment (Refer to section 5b)

7. With appropriate training and support the senior leadership team have good capacity to make the necessary improvements. As they develop their working together as a team and the head teacher continues to gain experience they will be able to build on the progress already made (Governors Action Plan)

8. The school has very supportive and knowledgeable governors who have got to know the school well during the last few months. Committee groups are effective and there is well planned action for improving the governance of the school further. This supports school leadership (Governors File)

9. Parents are supportive of the school and there are plans to involve parents further in their children’s learning (Refer to section 4g)

7b. What is the effectiveness of any steps taken to promote improvement since the last inspection, and as a results of your self-evaluation?

- Revised timetable for assessment has ensured whole staff understanding and commitment
- All staff involved in analysing standards and setting targets for future learning, this is now informing planning and staff have a better understanding of the progress children are expected to make throughout the year
- Improved assessment in KS means that the school now has a clear understanding of attainment on entry
Revise PPA time allows for professional development of TA's and provides curriculum enrichment. It also enables children from different classes to work together, developing their social skills.

Improved resources supports teaching and learning throughout the school in all subjects.

Revised planning for FS meets the needs of young children and is well linked to the curriculum.

Improved provision for PE allows for children to participate in a range of physical activities. The school provides 2 hours of PE each week for all children. Gymnastic resources sill need improving.

 Provision for ICT is good, new computer suite and interactive whiteboards have improved standards. The school is benefiting from support from AST.

Differentiation has improved, the school is aware of the need to provide appropriate challenge for higher attainers.

Standards in geography have improved; better planning and resources, different staff more confident teaching. Plans are monitored assessment linked to QCA. There are plans to improve assessment further (Refer to section 5).

Standards in English are improving because of a range of initiatives (Refer to section 3, 7a)

The school has improved the ways in which it evaluates its progress;

- Analysing test results
- Monitoring of lessons, teachers plans
- Lesson evaluations used to inform planning
- Seeking views of children and parents
- Assessment practices such as First of the Month Books
- Improved assessment, regular testing, individual targets
- Governors Committees more effective, better understanding of school requirements
- SIP reviewed termly with Governors

The school building has undergone major renovation since the last inspection. This has improved the learning opportunities for all children, new ICT suite, new FS classroom, administration area is attractive and well organised.

Professional development is well planned and evaluated to ensure staff and the school benefit as much as possible.

7c. What is the capacity to make further improvement?

The schools' capacity to improve is good

- Permanent leadership team will be in place from Jan 07, committed to bringing about whole school improvement.
- Secure evaluation clearly identifies schools strengths and weaknesses (SEF)
- School Improvement Plan follows on well from previous plan addressing main areas for improving standards throughout the school (SIP)
- Staff have much clearer understanding of tracking procedures and are more involved in data analysis for improving teaching and learning opportunities (SIP, Evaluation)
- An effective and knowledgeable governing body supports the work of the leadership team (Governor File)

7d. How effective are links with other organisations to promote the well-being of learners?

The school has improved links with the community in recent years this supports teaching and learning in PSHE, geography, history, RE and PE

- Contributes to village Newsletter
- Developing links with the playgroup, regular visits
- Good links with the church to support learning in RE, art, History
- After school club is held in Church Hall, children from other schools attend
- Use of Church field for sport
- Christmas Fete in village hall, well attended by community members
- Open days, coffee mornings for local residents
- Good links with school nurse, local police
- Developing links with Parish Council
- Visits from local Fire Brigade, Karate Club
7e. What steps need to be taken to improve the provision further?

We are currently working on ideas for extending our links with the community. A newly appointed governor has particular expertise in this area and is currently helping the school to identify further improvements.

- To use the knowledge and skills of local residents to support learning.
- To provide workshops, visiting speakers and opportunities for our parents and those of other children in the village to meet together.
- To invite the playgroup to school concerts and other events.
- To use the environment more regularly to support our work in geography, history PSHE.

7f. Where relevant, what are the quality and standards in the Foundation Stage?

The quality and standards in the Foundation stage is satisfactory overall.

- The standards on entry are low, particularly in PSE, CLL and in mathematical awareness (Baseline data).
- The school now has more accurate data about children's attainment on entry and uses this information to support these needs. (School Profile, Planning File).
- Improved systems for recording day to day assessments allows for achievements to be carefully monitored and fed into weekly plans (Assessment File).
- Improved resources support teaching and learning, impact monitored at end of school year.
- Very enthusiastic Teacher who is willing to develop her own understanding of teaching young children is gaining in experience and confidence.
- The curriculum offers a wide range of learning opportunities, there are good links with other subjects and topics are well chosen to meet the needs and interests of our children (Planning File).
- There are good opportunities for communicating with parents which supports children's learning (FS File).
- The care and guidance offered to children and their families is good (LM File, FS File).

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Appendix F: Examples of letters of informed consent (signatures hidden)
Dear

REQUEST FOR INFORMED RESEARCH CONSENT

As part of my Ph.D. studies I am investigating the role of language in the learning, teaching and assessment of mathematics. As you know, many children have difficulty with mathematics. Previous research that I have done has suggested that an issue may lie in the kind of language used in mathematics lessons and that used in everyday talk. I also know that autistic children who have problems with language can also be very good at mathematics. So the research will allow us to find out the importance of language by identifying the kind of language that maximises children’s understanding of mathematics.

I would be delighted if you could help by agreeing to take part in a recorded numeracy lesson and the interview to follow.

All the information that I collect will be kept confidential and will not be passed on to any third party in a form where the school or any of the participants can be identified.

It is perfectly acceptable for you not to participate or to stop at any point during the research that you want. Your participation or non-participation in this research will not affect your status in the school or your standing in the classroom. Furthermore your participation in this research is not in response to financial or other inducements.

At your request, I will also make my findings available to you when I am finished with my research. If you are interested, please contact me on 01234 213406 or at andrearaiker@tiscali.co.uk. You can also contact me if you have questions about the study after you have completed your part in the research.

If you have read and understood the above, and do not have any questions about the research and your part in it, please sign your name below.

________________________________________________________________________

I volunteer to participate in this study, entitled ‘The implications of language for the learning, teaching and assessment of mathematics’.

Participant's name: [Redacted]

Signature of Participant: [Redacted]

Researcher’s name: Andrea Raiker

Researcher’s signature: [Redacted]

Date: 8.11.06
Dear [Name],

REQUEST FOR INFORMED RESEARCH CONSENT

As part of my Ph.D. studies I am investigating the role of language in the learning, teaching and assessment of mathematics. As you know, many children have difficulty with mathematics. Previous research that I have done has suggested that an issue may lie in the kind of language used in mathematics lessons and that used in everyday talk. I also know that autistic children who have problems with language can also be very good at mathematics. So the research will allow us to find out the importance of language by identifying the kind of language that maximises children’s understanding of mathematics.

I would be delighted if your school could help by allowing me to:

- record numeracy lessons in your school, using video and audio equipment;
- interview the teachers, paraprofessionals and children involved in the lessons;
- have access to archived data on the performance of children in English and numeracy.

I attach a list of undertakings that will ensure that the research meets fully the ethical issues involved. These include a presentation of a summary of the research’s findings to yourself, governors and anyone else you wish to be present.

All the information that I collect will be kept confidential and will not be passed on to any third party in a form where the school or any of the participants can be identified.

If you agree to this research taking place at our school, I would be grateful if could sign the copy of this letter attached and return to me.

Best wishes,

ANDREA RAIKER

I agree to the research outlined in this letter, to be carried out under the ethical procedures detailed in the attachment, to take place at [Place].

Name of Headteacher [Redacted]

Signature of Headteacher [Redacted]

Date: 6th October 2006
ETHICAL UNDERTAKINGS

Presentation to governors for consent.

Presentation to teachers and paraprofessionals for consent.

Individual letter of informed research content signed by all teachers and paraprofessionals involved.

Individual letter of informed research content signed by all parents/carers of the children involved.

All information to be kept confidential and will not be passed on to any third party in an identifiable form.

The research site and individuals involved to remain anonymous in any documentation resulting from the research.

Any paperwork included in the thesis that might identify the school or individual involved in the research will be anonymised.

The recordings will be given to the school following the completion of the research.

All copies of archived data and documentation to do with the participating schools and individuals to be destroyed on completion of the research.

A summary of the research will be presented to the headteachers and governors of the two schools involved.

Findings will be made available to the individuals involved on request.
Appendix G: Ethics approvals
Andrea Raiker  
P2:22  
Polhill Campus  
DMU- Bedford  

4th April 2003  

Dear Andrea  

I am writing to inform you that the Higher Degrees Committee held on 21st March 2003 agreed that your Application to Register for Doctor of Philosophy be approved.  

If you require any further information, please do not hesitate to contact me.  

Yours sincerely,  

Joanne Cooke  
Research Office Manager
Faculty of Education and Contemporary Studies
Human Research Ethics Proposal Form

Name
Investigators
Andrea Raiker

Title of Research Project
The role of linguistics in the learning, teaching and assessment of mathematics: a study of primary school children in the UK

Purpose of Study (Questions to be investigated/answered)
What is the role of teacher-generated language in the learning, teaching and assessment of mathematics?
What is the extent of the role of peer-peer language in the learning, teaching and assessment of mathematics?
What are the implications of the insights given by linguistics into the learning, teaching and assessment of mathematics?

Statement on Research Procedures and Methodologies (Including details of arrangements for participation of human subjects, including recruitment, consent and confidentiality procedures and documentation)

Participants: teachers, teaching assistants and other paraprofessionals, and children in a village lower school in Bedfordshire and a village primary school in Cambridgeshire.

See Appendix A

Risk Assessment: electronic equipment is unwired. Cameras will be placed out of children’s reach. Microphones will be velcroed under tables and therefore out of the way.

Payments to Participants: none.

Starting Date: November 2006

Likely duration of project: three months
HRE Issues Checklist (for completion by supervisor in the case of undergraduate research)

Has the research proposal identified any of the following research procedures? (Circle/Underline):
1. Gathering information about human beings (and organisations) through:
   - Interviewing
   - Surveying
   - Questionnaires
   - Observation of human behaviour
   - Taking human tissue/fluids
   - Interfering in normal physiological and/or psychological processes
2. Using archived data in which individuals are identifiable
3. Researching into illegal activities

If any of the above are circled/underlined, does the proposal satisfactorily identify the ways in which the student will be dealing with the following (tick boxes for “Yes”):

- [ ] Voluntary participation without inducement;
- [ ] Procedures for providing participants with full awareness of the objectives of the research, the procedures to be followed, and the anticipated outcomes particularly in respect of publication of findings;
- [ ] Proposal has met the criteria for respect for confidentiality and publication contained in Human Research Ethics Committee policy
- [ ] Research proposal form completed appropriately
- [ ] Informed consent completed appropriately

Do the procedures identified in the proposal necessitate full formal risk assessment? [YES/NO]
Has the risk assessment been carried out? [YES/NO/NONE REQUIRED]
Does this assessment fall within university limits? [YES/NO/NONE REQUIRED]

Signature of Reseacher: [Signature]
Date: [Date]

Signature of Supervisor (if applicable) to confirm they are satisfied with the ethical provision:

[Signature]
Date: [Date]

Confirmation of Approval by School Human Research Ethics Committee (when required)

Signature of Chair: [Signature]
Date: [Date]
Appendix A

Research questions

1. What is the role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

2. What is the role of peer-peer language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

3. What are the implications of the insights given by linguistics into the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

Research methodologies

This study investigates the role of language used during numeracy lessons between teacher-pupils and pupils-pupils. Methodologies will result in data provided by spoken and written language, non-verbal communication and documentation. Methodologies will address:

- The formal language of teaching, learning and assessment in mathematics;
- The informal language of teaching, learning and assessment in mathematics;
- The language that arises from social interactions in which the formal and informal language of learning, teaching and assessment in mathematics is embedded;
- The non-verbal language in which the language that takes place in mathematics lessons is embedded;
- The physical resources of the classroom, including the classroom itself, in which and through which teaching, learning and assessment in mathematics takes place;
- The documentation that directs and records the teaching, learning and assessment of mathematics.

The study will take the form of a maximum of 6 synchronised wireless video and audio recordings of numeracy lessons in the two schools, followed by structured and unstructured interviews. Please see attached timetable for the pilot (Appendix A1). The researcher will take notes during the recordings. The recordings will be shown to the teachers, teaching assistants and other paraprofessionals, and children involved as semi-structured interviews. Subsequently teachers, teaching assistants and other paraprofessionals will be asked to take part in semi-structured interviews. Lesson plans and written work resulting from the lessons will be collected. The headteachers will be interviewed to provide an overview of current data on policies, test performances and related documentation in numeracy and English. The schools will be asked to provide relevant copies of archived data on policies, test performances and related documentation on the schools' and children’s performances in numeracy and English.
Research procedures

- Approach headteacher for consent (Appendix A2)
- Presentation to governors for consent.
- Presentation to teachers and paraprofessionals for consent.
- Individual letter of informed research content signed by all teachers and paraprofessionals involved (Appendix A3).
- Individual letter to all parents requesting their consent. Proforma attached (Appendix A4. Produced after consultation and advice from Headteachers).
- Interview schedule for headteacher approved by Ethics Committee (Appendix A5).
- Interview schedule for teachers/paraprofessionals approved by Ethics Committee (Appendix A6).
- Interview schedule for children approved by Ethics Committee (Appendix A7).
- All information to be kept confidential and will not be passed on to any third party in an identifiable form.
- The research sites and individuals involved to remain anonymous in any documentation resulting from the research.
- Any paperwork included in the thesis that might identify a school or individual involved in the research will be anonymised.
- The recordings will be given to the schools involved following the completion of the research.
- All copies of archived data and documentation to do with the participating schools and individuals to be destroyed on completion of the research.
- A summary of the research will be presented to the headteachers and governors of the two schools involved.
- Findings will be made available to the individuals involved on request.

Primary analysis tools

The data collected through the recordings, interviews and note-taking during the lessons will be analysed by three methods:

a. Word analysis (WA)

a(i) The number of different mathematical words and phrases used by teachers and children will be identified and compared;

a(ii). The language used in the teaching, learning and assessment of mathematics will be sorted according to Shuard and Rothery’s (1984) categories of mathematical vocabulary, that is:

- technical words- words which have a meaning only in mathematical English, for example algebra, calculus, polygon;
- lexical words- words which have a similar meaning in mathematical English as in everyday English, for example equal, parts, altogether, ,
- everyday words- words which occur both in everyday English and mathematical English but which can have similar and different meanings in mathematical
English from their meaning in everyday English, for example difference, product, odd, and.

b. Sentence analysis (SA)

A phenomenological analysis following Hycner 1985 in which transcripts of spoken and written language are analysed for the identification of themes. The following examples are taken from my Masters' research and subsequent research into written language used in numeracy tests:

b(i) Teacher-generated language

<table>
<thead>
<tr>
<th>Teachers</th>
<th>cq</th>
<th>closed questions- have only one answer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>lq</td>
<td>leading questions</td>
</tr>
<tr>
<td></td>
<td>oq</td>
<td>open questions- have more than one answer</td>
</tr>
<tr>
<td></td>
<td>puml</td>
<td>poor use of mathematical language</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td>explanation</td>
</tr>
<tr>
<td></td>
<td>i</td>
<td>instruction</td>
</tr>
<tr>
<td></td>
<td>ms</td>
<td>mathematical statements e.g.&quot;I'm going to split mine into twenty-two&quot; (B4)</td>
</tr>
<tr>
<td></td>
<td>ag</td>
<td>answers given- the teacher waiting less than 5 seconds for an answer then giving it</td>
</tr>
<tr>
<td></td>
<td>tpi</td>
<td>an aspect which does not involve words but involves understanding and is therefore of interest to this study is the opportunity for a teaching point being ignored.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Children</th>
<th>na</th>
<th>number answers</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ms</td>
<td>mathematical statements e.g.&quot;Numerator on the top and denominator on the bottom&quot; (B4)</td>
</tr>
<tr>
<td></td>
<td>ot</td>
<td>open thinking for examples see C3/4</td>
</tr>
<tr>
<td></td>
<td>puml</td>
<td>poor use of mathematical language</td>
</tr>
<tr>
<td></td>
<td>e</td>
<td>explanation</td>
</tr>
</tbody>
</table>

b(ii) Peer-peer language

<table>
<thead>
<tr>
<th>cq</th>
<th>closed questions- unlike the teacher who knew the one answer the children did not and therefore it could be argued that this category as open. However the children were expecting only a single answer so their questions are closed.</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
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<td></td>
<td>i</td>
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<td>ms</td>
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<td>nms</td>
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<td>ev</td>
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<td></td>
<td>sin</td>
</tr>
<tr>
<td></td>
<td>lmk</td>
</tr>
<tr>
<td></td>
<td>lmu</td>
</tr>
</tbody>
</table>

b(iii) Written language
<table>
<thead>
<tr>
<th>Category</th>
<th>Abb.</th>
<th>Sub-category</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Symbolism</td>
<td>l</td>
<td>lexical</td>
<td>The written word</td>
<td>How much does the cheapest pizza cost?</td>
</tr>
<tr>
<td></td>
<td>m</td>
<td>mathematical</td>
<td>Symbols used in mathematics that are neither numerical or operational</td>
<td>£, =, ≤</td>
</tr>
<tr>
<td></td>
<td>n</td>
<td>numerical</td>
<td>A number written as a symbol</td>
<td>12, 6</td>
</tr>
<tr>
<td></td>
<td>o</td>
<td>operational</td>
<td>Indicating a mathematical operation</td>
<td>+, ÷</td>
</tr>
<tr>
<td></td>
<td>in</td>
<td>informative</td>
<td>Informing the pupil to indicate a response in a particular way.</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>p</td>
<td>pictorial</td>
<td>Represented as a picture</td>
<td>A coin, a lorry</td>
</tr>
<tr>
<td>Representations</td>
<td>t</td>
<td>tabular</td>
<td>Numbers presented in a table</td>
<td>pizza price list</td>
</tr>
<tr>
<td></td>
<td>g</td>
<td>graphical</td>
<td>Numbers represented as bars, blocks, segments or co-ordinates</td>
<td>bar charts</td>
</tr>
<tr>
<td></td>
<td>is</td>
<td>irregular shapes</td>
<td>Any shape that is not regular</td>
<td>J</td>
</tr>
<tr>
<td></td>
<td>rs</td>
<td>regular shapes</td>
<td>A shape that has some degree of uniformity and has been given a particular mathematical name</td>
<td>Square, circle, pentagon</td>
</tr>
<tr>
<td>Syntax</td>
<td>swE</td>
<td>written English</td>
<td>Words written in an recognised order to give meaning</td>
<td>Look at this pattern. 'Pattern this at look does not make sense.</td>
</tr>
<tr>
<td></td>
<td>sm</td>
<td>mathematical</td>
<td>Numbers written in a recognised order to give meaning</td>
<td>7 + 3 = 10. 1073 = + does not make sense.</td>
</tr>
<tr>
<td>Others</td>
<td>la</td>
<td>lexical</td>
<td>A letter or series of letters that represent a longer word.</td>
<td>p for pence</td>
</tr>
</tbody>
</table>
c. Context analysis

c(i) An analysis of classroom climate, that is of the effectiveness of the classroom as a place where the teaching, learning and assessment of mathematics can take place. Categories will follow Mehrabian (1974) and Knapp & Hall (2006) being:

- Stimulating/non-stimulating
- Pleasant/unpleasant
- Formal/informal
- Warm/cold
- Private/public
- Familiar/unfamiliar
- Constraining/free
- Distant/close

Also the architectural design of the classroom, the configuration of moveable objects, lighting, sound, colour and general visual-aesthetic appeal will be considered.

c(ii) An analysis of the resources used in the teaching, learning and assessment of mathematics. Categories will be adaptations of Mehrabian (1974) and Knapp & Hall (2006) being:

- Stimulating/non-stimulating
- Pleasant/unpleasant
- Familiar/unfamiliar
- Constraining/free
- Distant/close
- Real world/abstract
- Verbal/non-verbal

c(iii) An analysis of the non-verbal communication (NVC) accompanying the teaching, learning and assessment of mathematics. Coding will be used to denote the following:

- Speech dependent/speech independent
- Self touching/interpersonal touching (sub-categories: field appropriate/social/friendship)
- Gaze engaged/gaze disengaged
- Facial expression (sub-categories: smile/frown/neutral)
- Vocal cues (sub-categories: high/low, loud/soft, fast/slow)

c(iv) A contents analysis on current data on planning, policies, test performances and related documentation

c(v) A contents analysis on archived data on planning, policies, test performances and related documentation

Below is a table relating research questions, methodologies and analysis tools
<table>
<thead>
<tr>
<th>Research question</th>
<th>Instrument/activity</th>
<th>Data gained on</th>
<th>Analysis tool</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 and 2</td>
<td>Lesson plans</td>
<td>Formal written language, Classroom climate, Resources</td>
<td>CA iv</td>
</tr>
<tr>
<td>1 and 2</td>
<td>Filming of numeracy activities within the creative curriculum/whole class numeracy lesson</td>
<td>Formal and informal spoken language, Non-maths, social language, NVC, Classroom climate, Resources</td>
<td>WA ai, aii, SA bi, bii, CA ci, cii, ciii</td>
</tr>
<tr>
<td>1 and 2</td>
<td>Field notes</td>
<td>Classroom climate, Resources</td>
<td>CA ci, cii</td>
</tr>
<tr>
<td>1 and 2</td>
<td>Interview with teacher/paraprofessionals</td>
<td>Formal and informal spoken language, Non-maths, social language, NVC, Classroom climate, Resources</td>
<td>WA ai, aii, SA bi, bii, CA ci, cii, ciii</td>
</tr>
<tr>
<td>2</td>
<td>Showing of recordings to teacher/paraprofessionals</td>
<td>Formal and informal spoken language, Non-maths, social language, NVC, Classroom climate, Resources</td>
<td>WA ai, aii, SA bi, bii, CA ci, cii, ciii</td>
</tr>
<tr>
<td>2</td>
<td>Interview with children</td>
<td>Formal and informal spoken language</td>
<td>WA ai, aii, SA bi, bii, CA ci, cii, ciii</td>
</tr>
<tr>
<td>2</td>
<td>Showing of recordings to children</td>
<td>Formal and informal spoken language</td>
<td>WA ai, aii, SA bi, bii, CA ci, cii, ciii</td>
</tr>
<tr>
<td>1 and 2</td>
<td>Children’s work</td>
<td>Written language</td>
<td>civ</td>
</tr>
<tr>
<td>3</td>
<td>Headteacher interview</td>
<td>Current policies, test performances and related documentation</td>
<td>civ</td>
</tr>
<tr>
<td>3</td>
<td>Contents analysis of archived</td>
<td>Archived policies, test performances and related documentation</td>
<td>cv</td>
</tr>
</tbody>
</table>
Secondary analysis tool

The primary analysis tools will enable judgements to be made on the role of teacher-generated and peer-peer language on the teaching, learning and assessment of mathematics in lower schools in Bedfordshire. Secondary analysis will allow the identification of Individual Learning Events (ILE). The, teachers, paraprofessionals and children will have the opportunity to look at the recordings and identify and provide evidence for points when they feel learning has occurred. The researcher will enter these points and the evidence given on the grid below. This will enable the researcher to make judgements on the role of language among other variables and the extent of its impact on teaching, learning and assessment of mathematics for lower school aged children. This will then enable the researcher to make judgements on the implications of the insights from linguistics in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range.

The grid is divided vertically into four sections. These can be extended to the right if necessary. From the left these are:

- Time- this will allow synchronisation and sequencing ILEs
- Individual use of verbal, non-verbal and written communication. The type of these will be given by code.
- Interactions- the social use of verbal and non verbal communication, and the written work produced during these social interactions.
- Identification of ILEs- points when teachers, children and paraprofessionals identify that learning has taken place and provide evidence for it.

<table>
<thead>
<tr>
<th>Time</th>
<th>Individual</th>
<th>Interactions</th>
<th>Identification of ILEs</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>V</td>
<td>NVC</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>V</td>
<td>NVC</td>
<td>W</td>
</tr>
<tr>
<td></td>
<td>T'r</td>
<td>Ch</td>
<td>TA1</td>
</tr>
<tr>
<td></td>
<td>TA2</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

lix
Appendix H: Interview schedules
Questions to children

Questions to Reception

Why do you come to school?

What have you been learning today in numeracy?

What important words have you learnt today?

Tell me about your numeracy lesson today.

This is a video of your numeracy lesson today. What were you learning about in the lesson?

What did you learn today?

Questions to Years 1/2

What have you been learning today in numeracy?

What do you feel today about your learning in numeracy? (Use traffic light system of showing confidence in learning).

What important words have you used in your numeracy lesson today?

Tell me about your numeracy lesson today.

This is a video of your numeracy lesson today. When did you feel you’d learnt something? Put your hand up and tell me.

What did you learn today?

Questions to Years 3/4

What have you been learning today in numeracy?

What do you feel today about your learning in numeracy? (Use traffic light system of showing confidence in learning).

What key vocabulary have you used in your numeracy lesson today?

Tell me about your numeracy lesson today.

This is a video of your numeracy lesson today. When did you feel you’d learnt something? Put your hand up and tell me.

What did you learn today?
Questions to teachers and teaching assistants

Research questions

What is the role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

What is the role of peer-peer language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

What are the implications of insights given by linguistics into the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

Interview questions: teacher/teaching assistant

What do you understand by the word ‘language’?

How important do you think language is for you as a teacher of numeracy?

In what way do you think is language important?

How does this importance come out in your teaching?

What else besides language do you think is important in teaching children numeracy?

Is it important that children get the opportunity to talk in numeracy lessons?

Why is it important that children talk in numeracy lessons?

When should they be encouraged to talk?

How do you know that a child has learnt according to the learning objectives of the mathematics lesson?

How accurate do you think is this assessment?

Do you think that your assessment of what has been learnt in a numeracy lesson is the same as your children’s perception of what they have learnt?

What are your reasons for saying this?
Questions to headteacher

Research questions

What is the role of teacher-generated language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

What is the role of peer-peer language in the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

What are the implications of insights given by linguistics into the learning, teaching and assessment of mathematics for children in the 4 to 9 age range?

Interview questions: Headteacher

What do you understand by the word ‘language’?

How important do you think language is for you as a teacher of numeracy?

In what way do you think is language important?

How does this importance come out in your teaching?

What else besides language do you think is important in teaching children numeracy?

Is it important that children get the opportunity to talk in numeracy lessons?

Why is it important that children talk in numeracy lessons?

When should they be encouraged to talk?

In your view, what are the key assessments that should be carried out to ascertain attainment in numeracy?

Do you think that the assessments carried out in class accurately capture a child’s attainment in numeracy?

Do you think SATs accurately capture a child’s attainment in numeracy?
Appendix I: Brenner et al.'s approach to content analysis
Brenner et al.'s (1985) approach to content analysis applied to current research

Step 1: Understanding the area of research in context

Step 2: Selecting the sample for research

Step 3: Placing the approach in relation to the statement of self and literature to ensure compatibility, validity and reliability

Step 4: Placing the approach in relation to the research questions

Step 5: Placing the approach in relation to author's previous research

Step 6: Immersing the self in the data to become attuned to its nuances

Step 7: Categorising the data to reflect the research questions, ensuring that the list is exhaustive and categories are mutually exclusive

Step 8: Reflecting on the categorization

Step 9: Reviewing the categorisation

Step 10: Piloting the categories with an independent authority

Step 11: Making meaning out of the categories

Step 12: Writing about the categories

Step 13: Synthesising with other methodologies to achieve triangulation
Appendix J: Coding of interview utterances for content analysis
CODING AND QUANTIFYING ANSWES TO INTERVIEW QUESTIONS

Q1 What do you understand by the word 'language'?

| SOL | 1 |
| IVC | 1 |
| BL | 1 |
| COMU | 1 |
| SL | 1 |
| DEFL | 1 |
| BLDW | 2 |
| IMP | 1 |
| WC | 2 |
| WL | 1 |
| OL | 1 |
| MOV | 2 |
| PL | 4 |
| EWYD | 2 |
| WYU | 1 |
| CU | 15 |
| TSF | 7 |
| PSE | 2 |
| DWFST | 1 |
| DWSTC | 2 |
| PI | 1 |

Q2 How important do you think language is for you as a teacher of numeracy?

| MOL | 1 |
| TV | 1 |
| E | 1 |
| SL | 1 |
| SM | 1 |
| CC | 2 |
| CM | 2 |
| CU | 3 |
| SPL | 1 |
| SLG | 1 |
| TNGM | 1 |
| ESS | 3 |
| CTAW | 2 |
| AB | 1 |
| PF | 1 |
| DEM | 1 |
| MM | 1 |
| DC=DM | 3 |
| DC0=DM | 1 |
| DWDST | 1 |
| CON | 1 |
| LLA | 3 |
| MI | 1 |
| IU | 5 |
| PA | 4 |
| MS | 1 |
| SM | 1 |
| ASSM | 2 |
Q3 In what way do you think is language important?

<table>
<thead>
<tr>
<th>CTWT</th>
<th>2</th>
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<tbody>
<tr>
<td>TEX</td>
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<td>NLTT</td>
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</tr>
<tr>
<td>RRFA</td>
<td>1</td>
</tr>
<tr>
<td>URWRR</td>
<td>1</td>
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</table>

Q4 What else besides language is important in teaching children numeracy?

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<th>D</th>
<th>1</th>
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<tbody>
<tr>
<td>RV</td>
<td>5</td>
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<tr>
<td>LS</td>
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<td>NNSITV</td>
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<td>R</td>
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<td>PSA</td>
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<tr>
<td>RLA</td>
<td>2</td>
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<tr>
<td>LO</td>
<td>1</td>
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<tr>
<td>LGS</td>
<td>2</td>
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<tr>
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<td>TOS</td>
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<td>TSK</td>
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<td>IUWR</td>
<td>1</td>
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<tr>
<td>VIL</td>
<td>1</td>
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</table>

Q5 Is it important that children get the opportunity to talk in numeracy lessons?

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<th>V</th>
<th>1</th>
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<tbody>
<tr>
<td>TA</td>
<td>2</td>
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<tr>
<td>SL</td>
<td>1</td>
</tr>
<tr>
<td>THT</td>
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<tr>
<td>NL</td>
<td>1</td>
</tr>
<tr>
<td>NUT</td>
<td>2</td>
</tr>
<tr>
<td>SET</td>
<td>1</td>
</tr>
<tr>
<td>LP</td>
<td>3</td>
</tr>
</tbody>
</table>
Q6 When should they be encouraged to talk?

| MOS | 2   | 1 |
| QA  | 1   | 3 |
| CCC | 2   | 3 |
| DAI | 1   |   |
| TTP | 5   | 3 |
| PL  | 1   | 1 |
| PR  | 1   | 1 |
| P   | 1   | 1 |
| CAT | 2   |   |
| CTTC| 2   | 1 |
| TQ  | 2   |   |
| UL  | 1   |   |
| APL | 2   |   |
| TT  | 6   | 3 |
| NL  | 1   | 1 |
| B   | 1   | 5 |
| CTWEO|10|1|
| TQ  | 1   |   |
| VOL | 1   | 1 |
| GS  | 1   |   |
| LOC | 2   |   |

Q7 Key assessments carried out to ascertain attainment in numeracy?

| RL  | 3   | 5 | 1 |
| PSAS| 3   |   |
| RR  | 6   |   |
| OA  | 4   | 2 | 1 |
| WA  | 2   |   |
| NFIA| 1   |   |
| Tel | 1   |   |
| IA  | 1   |   |
| FA  | 3   |   |
| IDA | 4   |   |
| AFAS| 1   | 1 |
| QWA | 1   |   |
| TL  | 2   |   |
| PSAS| 1   |   |
| NCL | 1   | 1 |
| RL  | 1   |   |
Q8 Assessments carried out in class, accurately capture a child’s attainment?

<p>| | |</p>
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<td>EWT</td>
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</table>

Q9 Is there anything else you would like to say about language and numeracy?

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Q8 How do you know that a child has learnt according to learning objectives?

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Q9 How accurate do you think is this assessment?

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<td>AIC</td>
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<td>TR</td>
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<tr>
<td>CSA</td>
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FIRST SORT TO IDENTIFY THEMES

LANGUAGE GENERAL

SOL  sorts of language  1
IVC  individual verbal code  1
WYU  words you use  3
BL  body language  1
BLDSW  body language gives different signals from words  2
COMU  common understanding  3
SL  speaking and listening  2
CON  conversation  1
AVL  aural and verbal language  2
DEFL  definition of language  1
IMP  importance of language  13
WC  way of communicating  4
WL  written language  1
OL  oral language  1
NVC  non-verbal communication  20
DC=DM  different children give different meaning to work  10
DCO=DM  different contexts give different meanings to work  4
DWDST  different words to describe the same thing  3
LLA  low language acquisition of children in school  4
PI  parental influence on language children use  1
CLL  children love language  1
CL  consolidates children's learning  1

LANGUAGE MATHS

MOV  maths has its own vocabulary  2
MOL  maths has its own language  12
E  enriches language  1
SL  special language  6
ESS  essential to do maths  3
V  vital to maths  2
TeL  technical language  1
SPL  specific language  4
SM  specific meaning  1
CC  common code  2
AB  abstract  1
SMW  spelling maths words  1
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<tr>
<td>CM</td>
<td>common meaning</td>
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<tr>
<td>CU</td>
<td>common understanding</td>
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<tr>
<td>SM</td>
<td>same meaning</td>
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<tr>
<td>SHL</td>
<td>shared language</td>
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<tr>
<td>SS</td>
<td>shared strategies</td>
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<tr>
<td>MI</td>
<td>many issues with language in maths</td>
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<td>DWFST</td>
<td>different words for same things in maths</td>
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<tr>
<td>DWSTC</td>
<td>different words meaning same thing in maths</td>
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<tr>
<td>WRW</td>
<td>wide range of words in maths</td>
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</tbody>
</table>

**MATHS**

| PA   | maths involves practical activity | 26 |
| PSA  | problem solving activities important in maths | 7 |
| PSAS | problem solving should be used as an assessment | |
| TOI  | children should try out ideas     | 4 |
| KWTD | have learnt when they know what they are doing | 2 |
| CONF | confusion when they don't know what they are doing | 5 |
| CAOL | children should assess their own learning of life | 5 |
| RLA  | maths should be about real-life activity | 4 |
| RLC  | maths should use real-life contexts | 4 |
| RV   | importance of visual resources    | 10 |
| LS   | resources engage different learning styles | 8 |
| NNSITV | NNS good for IT visual resources | 4 |
| R    | resources mentioned in relation to maths | 12 |
| RI   | resources make maths inclusive   | 1 |
| RELR | importance of resources being relevant | 2 |
| MS   | involves developing skills       | 1 |
| TOS  | maths skills should transfer to other subjects | 1 |
| LGS  | involves logic skills            | 4 |
| NELS | not enough logic skills practised | 1 |
| ASSM | teachers making assumptions about maths | 2 |
| WOT  | children work out problems together | 3 |
| D    | maths is difficult               | 1 |
| BAM  | SATs a broad assessment of maths  | 1 |
| MWA  | maths written assessment         | 1 |
| AD   | accurate on day                  | 2 |
| TL   | assessment of transfer of learning | 2 |
| RL   | assessment to check if learning retained | 1 |
| RA   | real assessment                  | 1 |
| SS   | formal assessment a snapshot     | 2 |
| CT   | train children for numeracy SATs | 4 |

**THE MATHS TEACHER**

| CV   | teacher must use correct vocabulary | 1 |

lxxiii
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<td>LTEPG</td>
<td>lack of teacher education post graduation</td>
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<td>lack of local authority support in maths</td>
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<td>TNGM</td>
<td>teacher not good at maths</td>
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<td>TSF</td>
<td>teachers' sharing feelings about teaching maths</td>
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<td>TUD</td>
<td>should understand children's difficulties</td>
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<tr>
<td>TAM</td>
<td>should admit own difficulties</td>
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<td>teachers learn maths from children</td>
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<td>should make mistakes on purpose</td>
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<td>OBS</td>
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<td>don't dumb down language</td>
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<tr>
<td>PL</td>
<td>key language in planning</td>
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<tr>
<td>NL</td>
<td>plan new language</td>
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<tr>
<td>MOS</td>
<td>plan for children to talk in mental/oral starter</td>
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<tr>
<td>PL</td>
<td>plan for children to talk in plenary</td>
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<td>LOC</td>
<td>language should be encouraged on the carpet</td>
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<td>GS</td>
<td>language should be encouraged in group sessi</td>
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<tr>
<td>APL</td>
<td>language should be encouraged in all parts of t</td>
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<tr>
<td>QA</td>
<td>plan Q/A into lessons</td>
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<tr>
<td>CAT</td>
<td>ask children to be teacher</td>
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<tr>
<td>ACTC</td>
<td>ask children to talk to class</td>
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<td>TT</td>
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<td>TLAM</td>
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<td>explain what you're doing to children</td>
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<td>MM</td>
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<td>CU</td>
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<td>GTRA</td>
<td>learnt when can give the right answer</td>
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<td>teachers should encourage talk</td>
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<td>children talking with teacher to understand</td>
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<td>NUT</td>
<td>children talking because they haven't understood</td>
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<td>giving feedback on talk</td>
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<td>children not talking not good</td>
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<td>allows assessment of individual understanding</td>
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<td>DAI</td>
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<tr>
<td>CAI</td>
<td>children as individuals</td>
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<tr>
<td>KCI</td>
<td>knowing children as individuals</td>
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</tbody>
</table>

**PEER-PEER LANGUAGE**

| CTAW | children talking about work - allows assessment | 14 |
| CTWEO | children should talk with each other in maths | 13 |
| CGI | children giving information                    | 1 |
| CFI | children finding out information               | 1 |
| VOL | volume of talking has to be managed            | 2 |
| B   | can mean poor behaviour                       | 7 |

| PSE | personal, social and emotional development    | 2 |
| CCC | children talk when they are comfortable and co | 5 |
| HWC | talking helps with confidence                 | 2 |
| LCMG | low confidence minimised by group working     | 1 |
| HCF | how children feel                             | 1 |
| SE  | self-esteem good for achievement in maths     | 1 |
| LE  | low esteem affects maths                      | 3 |
| TR  | are children telling the truth when answering m: | 2 |

| SF  | share findings                                | 4 |
| TA  | thinking aloud                                 | 2 |
| THT | thinking time before talking important         | 7 |
| SET | important to listen to someone else talking mat | 1 |
| LP  | listening to peers important                  | 9 |
| PL  | peer language aids understanding               | 2 |
| TTP | talking to peers good for understanding        | 8 |
| PR  | peers reinforce learning                      | 2 |
| AWP | learn another way through peers                | 1 |
| DIFT | learnt when do for themselves with/without lang | 5 |

**RESOURCES IN MATHS**

| RWL | using a word list as a resource               | 1 |
| IUWR | importance of using words with resources      | 1 |
| LO  | using lang not as good as using lang with resol | 1 |
| RRFA | importance of right resource for maths activity | 1 |
| URWRR | using right words with right resources         | 1 |
| VIL | visual resources as important as the language | 1 |

**LANGUAGE AND ASSESSMENT IN MATHS**

| RL | use language to test rote learning ie tables | 12 |
| RR | use language to test rapid recall            | 6 |
| OA | oral assessment                              | 7 |
| WA | written assessment                           | 2 |
| NTIB | use language not ticks in boxes              | 1 |
| IA  | language allows instant assessment           | 1 |
| FA  | language used in formal assessment           | 3 |
| WSNM | assessing written skills not maths           | 1 |
| RSNM | assessing reading skills not maths           | 1 |

ixxv
<table>
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<td>assessing handwriting skills not maths</td>
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<td>traffic light system to assess understanding</td>
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<tr>
<td>RTY</td>
<td>record too young</td>
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<tr>
<td>SIso</td>
<td>there should be simple solutions to assessment</td>
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</tr>
<tr>
<td>CT</td>
<td>can assess accurately over time</td>
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<td>AIC</td>
<td>can assess individual children accurately in maths</td>
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<td>difficult to assess some in maths</td>
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<td>Rel</td>
<td>retained learning</td>
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<td>age and therefore assessment related to learning</td>
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<td>the unusual circumstances of SATs</td>
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<td>children trained means a good teacher</td>
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<td>rely on tests in books</td>
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<td>CIR</td>
<td>circulate to assess</td>
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<td>children can't self-assess</td>
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<td>CTR</td>
<td>children taking on more responsibility for their learning</td>
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<td>MOTV</td>
<td>importance of motivation</td>
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Appendix K: Interview utterances; themes, subcategories and units of meaning
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<th>Units of meaning</th>
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<td>Body language</td>
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<td></td>
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<td>Body language gives different signals from words</td>
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<td></td>
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<td>Words you use</td>
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<td>Different children give different meanings to words</td>
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<td>Different contexts give different meanings to words</td>
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**Table 4: The maths teacher**
Table 5: Teacher generated language in maths

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**Table 6: Peer-peer language and mathematics**

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<tr>
<td>Querying assessment</td>
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<td>Seems to be assessment for assessment’s sake</td>
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<td>We should question why we are assessing</td>
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<td>We should be looking for real assessment</td>
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<td></td>
<td></td>
<td>Rely on tests in books which is bad</td>
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<tr>
<td>Other</td>
<td></td>
<td>Teachers should circulate to assess</td>
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<tr>
<td></td>
<td></td>
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<tr>
<td>Theme</td>
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<td>Units of meaning</td>
<td>Number of responses</td>
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<td>Accurate on the day</td>
<td>2</td>
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<td>A snapshot</td>
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<td>Observation</td>
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<td>Assess maths learning by observation</td>
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<td>Not enough assessment by observation</td>
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<td>Self-assessment</td>
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<td>Children should assess their own learning in maths</td>
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<td>Other</td>
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<td>Children have learnt when they know what they’re doing</td>
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Table 11: Assessment, mathematics and language

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<th>Number of responses</th>
<th>Total for subcategory</th>
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<td>Purposes of spoken language</td>
<td>To test rote learning in tables</td>
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<td>To test rapid recall</td>
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<td>Retained learning</td>
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<td>Allows instant assessment</td>
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<td>With traffic light system of assessment</td>
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<td>Purposes of written language</td>
<td>Formal assessment</td>
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<td>Assessing written skills not maths</td>
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<td>Assessing reading skills not maths</td>
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<td>Introduce written recording too young</td>
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<td>Accuracy of assessment</td>
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<td>Can assess individual children accurately</td>
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<td>Units of meaning</td>
<td>Number of responses</td>
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<td>Behaviour</td>
<td>Class rules</td>
<td>Volume of talking has to be managed</td>
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<td>Talking can mean poor behaviour</td>
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<td>Are children telling the truth when they answer maths questions?</td>
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<td>Confidence</td>
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<td>Children talk when they are comfortable and confident</td>
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<td>Talking helps with confidence</td>
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<td>Motivation</td>
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<td>Low confidence offset by group working</td>
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<td>Esteem</td>
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<td>Motivation is important</td>
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<td>Self-esteem good for achievement in maths</td>
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<td>Low esteem affects maths</td>
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<td>4</td>
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<td>Emotional development</td>
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<td>It's all about PSE</td>
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<td>How children feel is important in learning</td>
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<td>Responsibility</td>
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<td>Children should take on responsibility for their own learning</td>
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</table>
Appendix L: Transcripts of pupils' group interviews
Class 1: children's interview transcript - questions and answers

Q1  Why do you come to school?
A   Because we need to learn.
   To learn good stuff!

Q2  What good stuff were you learning this morning?
A   Fireworks, we were painting fireworks over there!

Q3  What were you learning with Mrs. A?
A   Umm, we were wanting him this side, and this side and that side and this side.....

Q4  Did you learn anything else (used teddy and box as prompt).
A   The inside (correct).
   On top (correct).
   At the front (correct)
   Back, back
   At the back.
   (Several) at the side.
   At the side, side (confusion)
Class 1: children's interview transcript - questions and answers

Q1 Why do you come to school?
A Because we need to learn.
To learn good stuff!

Q2 What good stuff were you learning this morning?
A Fireworks, we were painting fireworks over there!

Q3 What were you learning with Mrs. A?
A Umm, we were wanting him this side, and this side and that side and this side.....

Q4 Did you learn anything else (used teddy and box as prompt).
A The inside (correct).
On top (correct).
At the front (correct)
Back, back
At the back.
(Several) at the side.
At the side, side (confusion)
Class 2: children’s interview transcript- questions and answers

Q1 Does anybody know what numeracy means?
A It means do some hard work.

Q2 What was the hard work?
A Shapes and everything.

Q3 What did you learn today?
A Y1 The corners and the sides.
   Y1 We drawed round them.
   Y1 Pictures.
   Y1 Their faces.
   Y1 We learnt how to draw round triangles.
   Y1 We were learning about points and sides.
   Y2 We had to cut out the shapes and put them in the circles (Venn diagram).

Q4 How do you know you’ve learnt about shapes?
A Y1 Because we’re drawing round them, we had to draw round them and we’re writing their names on them.
   Y1 Doing the sides and the corners.
   Y1 I wrote it all down.
   Y1 They helped me. I wrote down their names.
   Y1 I did all my work.
   Y2 It was a bit difficult on the names but it was alright.
   Y2 I know faces and edges and sides and points.
   Y2 I finished most of my work.
Class 3: children's interview transcript- questions and answers

Class interview with children- questions and answers

Q1  What did you learn today?
A  Y3 I didn’t finish my work.

Y3 We were counting in twos. We just used twos, we had to count up and do the sums.

Y3 We had to....we had to write the....we had to write in twos and then do the tables.

Y3 I got my pencil stuck in there.

Y3 We learnt to count in twos and how to do the two times table and how to count and do the three times table too.

Y4 Turn sums into smaller numbers (turn repeated additions into multiplications)

Y4 With the harder ones the number line was a bit easier.

Y4 I think I finished my fifth one.

Y4 I did all of them after being shown, the one with the smaller numbers.

Y4 I would have liked smaller numbers.

Y4 I learnt to double it each time because I pushed the number along to the next one.

Q2  How do you know that you’ve learnt?
A  Y3 I knew what to do and it was easy.

Y3 That you understand and don’t need any help.

Y3 Because we did all our work and Mrs C told us what to do.

Y3 Because Mrs C explained it.

Y4 Because when a teacher or someone asks you a question you know the answer.
Y4 When you start you know what to do.

Y4 I know that I've learnt because when I start, and it looks really impossible and I think what? Because you suddenly remember what to do about it, and I started and I could do it.

Y4 When you've done a few and you write it down and the bit that you've done and the last that you've done helps you know what to do and you write down all the answers and you know what to do next time.

Y4 Because I understand.

Y4 Because I know what to do.

Y4 Because the teacher explained it well and that helped.

Y4 Because the teacher explained it. At first I didn't know what to do, and then the teacher explained and then I knew what to do.
Appendix M: Sample transcript taken from video data
<table>
<thead>
<tr>
<th>Time</th>
<th>Child</th>
<th>NVC</th>
<th>Teacher A</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:00:12</td>
<td>Children and A sit in a circle</td>
<td>Secretary comes in with register. A gets up. Takes register, sits down.</td>
<td>Right. Are you ready? What we are going to do in this numeracy lesson, we're going to learn about something called positioning and that means, Child D, will you sit on your bottom, please, on your bottom. Excuse me a minute. And positioning is a really big word, isn't it (statement, not a question). But what it means is, it's where something is. So that I can say yo-o-o-u (emphasis) are all in front of me. This is my front. This is ....... where would this be? My back, behind me. And what's this. If this is the front and this is the back, where would this be? Good girl! Is this at the side as well? Yes, it is yes, so...listening...you need to be listening... Child A is sitting at the side of me. Child D, if he sits nicely, is in front of me. What's behind me? Is there...</td>
</tr>
<tr>
<td></td>
<td>Nods at Child A</td>
<td>Puts slip with behind in front of her. Puts slip in front, in front of that saying behind.</td>
<td>Good girl. Now I thought I could have something here. I'm going to ask you lots and lots of words that says behind...can you remember...we'll put that behind... Then we've got one that says in front. One that says on top, where would the top be?</td>
</tr>
<tr>
<td></td>
<td>Children B and C hands up. Child A, hand on head. Other hand, crooked at mouth. A puts slip of paper on her head.</td>
<td>Takes off paper, picks up another and looks at it. Shows the children.</td>
<td>Could be there, couldn't it. Like a hat, yeh, on top.</td>
</tr>
<tr>
<td></td>
<td>Shall I put it there (behind),</td>
<td></td>
<td></td>
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<tr>
<td></td>
<td>Hmmm</td>
<td></td>
<td>It says side. If this is the back and this is the front, where would I put the side, Child B (no inflexion. Sounds like a statement).</td>
</tr>
</tbody>
</table>

**Notes:**
- Back E F
- Side: A EF Yes
- The wall
- Child C: I know. That's A
- Child A: Like a best or pets head
- Child C: Like you're going to do magic.
- Child D: I know

**Image Notes:**
-麻烦
Child B There! (the lefthand side)

Child B pointing.
Smiling. A not noticed that Child B has correctly answered the question. Puts teddy to the side.

Tapping the word in front. Tapping the word behind. Takes slip with on of and puts it on the teddy's head.

Picking up slip, does not show word. Reads, does not show.

Moves slip with around in an arc in front of her. Repeats.
Moves slip from behind over and in front of the teddy, and back again.

Puts down slips. Places box in the middle of the circle, lid opening away from A. Lifts the lid up and down. Puts teddy on the box.

Puts teddy in the box. Takes teddy bear out of the box and puts on top. Puts slip with word top in front of teddy. Puts second slip on top of the first. Lifts box off box and places on floor behind box and in front of her.

Teddy, there's teddy. So the slip would have to go here (where Child B had pointed). Child D, you need to sit up please. Look at me and I need you to concentrate.

So that's in front of the teddy bear... that's behind the teddy bear... and at the side of the teddy bear (no taps). That would be on top of the teddy bear, wouldn't it (not a question). Will it balance on top (not a question), like a hat. And that says on. We'll save that one for later. That's in

I need you to listen... And around (extends the r sound)

Did you see how that goes? Around the teddy bear (extends the r sound). And over. Over! The teddy bear.

Now I'm going to put the teddy... no Child D (can't decipher words). I've got a box. It's from home. And I like this box because this box has got... what's this (no inflection). What is it? ( Waits for reply).

So if I sit the teddy bear... here... where would he be?

That's inside. That's inside. If I put the teddy bear here, where is he (no inflection).

He's on the top. So there he is... top... (undecipherable)... on top (with emphasis), isn't he, on top?

If I put the teddy bear here...

...where is he (no inf)
Child A Over

Child D Naughty

Child D Round

Child D Yes

Ch ABC. hands up. E - hands up

F hand up

Chorus No! D
Child. Yes!

Ch C
Chorus Side

Chorus No

Child No! Yes

Child A - hand to mouth. Neutral. A jigs tb up and down. Child D hand up, not seen. Child C hand up, not seen. Exaggerated jump from behind to in front to behind the box

Moves the teddy from the front round the side of the box to the back. Holds on knee

Repeats action.

Puts tb on top of the box. Gives the tb to Child D. Cuddles the tb Child D puts it inside the box. Taps it down. A frowns. Takes the lid from Child D and closes the lid. Touches her nose. Points at the box. All hand up bar Child E. A is smiling. Puts hand up.


Shows slip with side on it. A frowns. Nods.

Child A looks confused, but smiles and nods, then looks neutral. A puts hands either side of her face. Child B puts up hand, followed by Children C and D. Child B smiles. A neutral. Looking down

He's behind, isn't he. BEHIND the box. But he's a naughty tb, he's going to jump again... What's he doing now? What's he doing now? He's jumping... OVER the box.

He's on springs he's bit naughty, he over the box. Now he's going to move again. Where's he moving now (no inf).

Where's he moving (no inf). Around! Good boy! He's moving around the box.

Child D. Do you think you could put the tb inside the box (inf) Put the tb INSIDE the box.

Do you think he's right. Hands up if you think Child D is right. The bear's inside the box. (Whispers) I think so too. Child E (emphasised child's name, frown). Could you put the tb at the side of the box for me (frown). (Whisper) Take the tb for me. Put it at the side (inf), the side of the box for me. He's trying to help. Good girl. Please sit on your bottom, Child D.

Good girl. Is she right? Is the tb at the side of the box? Let's look if we're at the sides.

Is she right? I think she's right. She's right, you know! It's a tricky one but I think she's right. Do you think she's right, Child A?

OK, who else is going to have a turn.

Let's see... Child B. There's the

Could you put the tb....
Child A neutral, looking at A
Child B neutral
Child C neutral
Child D neutral fingers to mouth
Child E fiddling with back of shirt collar
Child E face unseen, pose neutral

Child B neutral. Child B looking at Child C. A leans forward. Child B looks at A.

A palm forward to Child D. Child B ready with tb. To Child F.

Points to Child B.
Looks like tb is going to be put at the side of the box. A takes tb before action finished and puts behind the box. B neutral. A fingers to mouth. Child A nods head and smiles. Takes tb and moves it over from back to front of box.

Child C hand up.

C hesitates.
C opens lid.
D fists on ears and rocking. C opens box, outs inside, closes lid with a bang. A tongue outside lips, shakes head.
F takes out tb and puts on top.

A hands to face

Child E Inside

Child C He's......

Oh E, Don't know

Chorus Yes!

Could you listen to the instruction first, my darling. Listen to where I'm going to ask you to put the teddy. Can you position the tb behind the box. It's a little bit tricky, isn't it. Good girl. Look, if you move that way a little bit... I'll move it so that it's slightly more behind. Let's see. You see?

So... Child D, you stay there... turn round this way for me. Sit this way... yes.

Behind the box

Hmm, Child A... can you put the tb over the box?

Let's see if you can do that. OVER the box! (as action takes place). Right. Who haven't I asked. Child C, can you put the tb on top... of the box.

On top, please.
Could you put him on top?
Child D! (frowns).

OwP! Is she right, is he on top of the box? Not on top of the box. Child F, could you put the tb on top of the box (no inf) Good girl.

Child C, when he's there (puts tb in the box) he's inside. When he's there (puts on top), he's on top. Are you ready? You need to listen. Hmmm. Child E, how about you ask Child A to put the tb somewhere. What could Child A put the tb.

Child A, inside the box, please. Child E wants you to put the teddy inside the box. I don't think he wants to go in the box again.- the box

Are you happy with that (looking at D). Are you happy (no answer from D). Is she right?
| Child D shakes head No! | Finger to lip.  
Child D goes to open the lid. A looks hard at D.  
Child F takes out the tb and puts in front of the box.  
Child C picks up teddy and looks at A.  
Indicates with finger the area. Puts at the side towards the back. C smiles. A frowns at D.  
Children BEF raise hands. Then C tentatively.  
Puts tb on top of the box. LEANS. LOOKS. LEANS. IT LOOKS SO WEIRD.  
Looks hard at D. Frowns.  
Points  
Looks skywards.  
Taps box with tb.  
D rocking too and fro.  
A frowns  
Indicates on top of with hand.  
Tilts box and puts tb under the box. Rocks box.  
D restless. A looks hard and frowns.  
D nods head in exaggerated manner.  
A points and pulls a | She is! Hmm. Child D, could you ask Child F to do something (decadence). Put the tb...position the tb.  
We're asking Child F. At the front of the box, Child F  
Good girl! In the front of the box. Hmmm, who else. Child D, child D, put it back please.  
No, he was in front, front of the box. Right, one more.  
Child C, could you put the tb at the side of the box (falling cadence).  
At the side...at the side  
She's right!  
I think she is! Put your hands up if you think she's put the teddy bear at the side of the box. See you're all saying no but you're all agreeing with me! What are you like? Today, I think you did very well with that. So...can you remember the name...of what we've done. That word, that special word? D, look at me. D, calm down, OK.  
Now, sit up straight. Now, what we're going to do today, over on the activity table, we've got...the doll's house, the dollies house. And we're going to put things inside (emphasis). Oh dear. (Words indecipherable)...We're going to put things inside the toy box...uh, the doll's house, sorry...it's inside the doll's house today. Things might go on the bed, they might go underneath...that's underneath. Teddy's underneath (not a question).  
He'll get squashed under there...and we're going to put all these inside the doll's house.... That's your last warning. OK?  
We're going to look inside the doll's house and position all the furniture and the dolls in the doll's house, OK? Then over on the table over there, there are lots of insects, lots of bugs all |
Child B puts hand up. Then A. Finger up. Points.

Child B I'm going to do my pet tomorrow.


Finger to mouth

Shaking head.

Thump out, in circular motion

Points. Leans forward

Indicates two by wagging finger

Finger in

Holds up hands

D points to classroom sink. Leans forwards, hands round tb.

A positions dh. Sit's down. Child B sits next to her. As they end's talk ChE

ChB points. ChB points at attic. ChB picks from box on floor next to her. ChE comes up. ChB puts bed in attic. Reaches

over the place! They are in one big muddle! I wonder if someone could put them in the right order and sort them in the right order into the bowls. Do you think you could do that, make it all nice and tidy. Yes? We're going to have a number of numbers on the computer. Child C was on that earlier and I'd like to see someone else on that today. Ok Child C we'll let someone else have a turn. Just a moment Child B. Over in that corner we've got writing letters... all them letters we've been learning about this term. You've done so well. We need to practise the. You can feel the paper, it's all bumpy and sandy on top, so you can run your finger over them and then write them with a pencil OK? And then we've got our pets' corner. You can sort out all the animals. (Indistinct)We've got to bandage up the animals if they are poorly. Ok, all right then? Do you all know... do you know what I've forgotten Child C. Just a minute. I'd forgotten. We can paint a picture now with a friend. An animal picture or a firework picture together? But let's see... I need you to listen first. Maybe you can do something together... with a partner... yeh? What must we wear for doing the painting. That's right. And where do we wash our messy hands. Is it in the toilet? That's right, messy hands in the sink. OK, then. Are we ready to go.

Child D In the toilet

On E I wanna painting.

Ch E I wanna paint.

Ch B Put some goats in there.

Ch B Up there

Right Child B, as you're here, shall we dress the doll's house. What shall we do in the doll's house? Where can we have the bedroom. What shall we put in the bedroom. Do you want to help us. We're going to have the bedroom up here.

civ 6
ChB Two

ChE Downstairs

ChE That one
Child E points to first floor. ChB still looking in box.
A pointing in turn to places in dh. A holding out hand with three fingers raised to ChE.
Uses flat hand to denote bottom, middle and top.
ChE nods.

ChB Me as well

ChB I’ve got hundreds...

ChE In the side
ChE moves cooker to downstairs right

ChB Toilet
ChB points to attic. A picks up wardrobe
ChB points to attic. A places wardrobe.
ChB rummaging. ChE looks at ChE’s dressing table.

ChB That side
ChB at the front
ChB Can we have this one
ChB at the front

0:15:20
Can we put that away

ChB This goes here, see

ChB This goes this way

Do you want another bed.
What’s this? No, it’s not another bed is it? .... Right then, where would you put the lounge?

Downstairs? ....

OK. That one. Is that downstairs (to ChE)... or... that’s upstairs, that’s downstairs. That’s not upstairs, that’s somewhere in the middle.
You’ve got three in your house haven’t you. Bottom, middle and top.

You as well?

You’ve got hundreds.... Where are we going to put...where are we going to put...

We’ll put that up there

Where does that belong.

What’s that. An oven, cooker....
So is that going to be our kitchen, then?

Over here. This is going to be the kitchen. Right, what else...

Toilet. Right where are we going to put this. This side or that side
Shall I put it, ChB

Look at me.
At the back or the front

At the front. What else.

Oooh, that’s a bit of a posh one.

Think it goes on the left. If this is our kitchen, where is the left. It goes here, in the middle.

Have you gone off it.

CV 7
ChE See
ChE goes at the top
ChB I got one
ChE I got four ones
ChE A toilet
Ch E this... watch

0:15:51

Let's see what's next. Have you found it. You got this. This goes down there.
Yes, at the top. Where are we going to have the

Where's that
It goes in the middle of the room like that (question).
Where does it go
Perhaps in the middle at the back of the house but what about this... we want this to be our bathroom where would the sink go.
Right in the middle of the room?

Where's that. It's in the corner
I think those might be drawers.
You use that to put your clothes in. Where would they go.

ChB, choose something.

What is it.

You want what... Alright where does it go... eh, the top
That's the top. What do you think that might be
It goes in the kitchen...
Kitchen cupboard. Where is it?
Where's that. Next to the ever... (indistinct) What else have we got in here
Mmmmm!
Where do you think that goes.

I love the table cloth on that. That's where we do our eating. Or do you do your eating on your knee. On your knee. I thought so. Right what do you do. What are you like. I sit at the table. We all have a family chat. Where do you think that goes.
Yes, that's right. We can change it. We can put it there in the middle, shall we. So we can sit around the table. Does that go outside or inside.
Inside
In the kitchen. Good girl.

ChB, I don't want this one I want...
ChB In there. That side

0:17:08

ChB In the kitchen... here

Ch B Downstairs

ChB That's outside and that's inside.
ChB In the kitchen

0:08:27

ChB, What I want, this
ChE Upstairs
B watching E, who places upstairs left.
E scratching back of neck

0:16:53

A leaning forward
A manipulates object in ChB's hands
B places object.
E moving objects in house
B sits down. All eyes on the box. B smiling. A picks up table and smiles.

ChB Downstairs

ChB, My family

ChB, It's we eat on our 'ceats

0:08:27

Gives to E who looks quizzical
E nods
Points at E

ChE with object
Puts inside
E moves object to the kitchen. Disturbance. All look up

ChD. Are you going to sort
ChE This is for the birthday girl to sit in.

ChB No that’s not... no not no that not go in the kitchen
ChE It goes outside.
It goes near to my feet.
ChB It goes in the bedroom.
ChB Leave it!

ChE \raise 3pt \textit{move it.}

It’s got rubies.

E rubs eyes. A looking away. B looking at D. E
at the box, stands up with armchair.
A smiles. B watching.

E puts in the kitchen. B
points

Ch E giggles. B puts in
bedroom. E puts back.
A looks over at another
group. Ch rummaging.
A looks away to
disturbance. E moves
towards a small doll

E places in kitchen

ChD comes over. A
gets away. The three ch
start to put objects in
the dh. ChB goes. E
points at box, hand
twisted outwards, digits
spread. Ch D and E go
away. A returns. Ch
B, D and E return. E
sits, D in front of dh,
A’s hand on B’s back.
D and B move to house,
A puts arms round B.

Looks at B, E looks
away.
Looks at D, who’s
looking into the house.
E picks up table.

E places table in house.

E sits down, fingers to
mouth, looks unsure. B
still constrained by E
E looks bright, points.
Moves objects. D
engaged. B looking. D
turns away, picks up
object. A lets B go, D
places object. E fingers
to mouth, looks unsure.
D shows A object.
B rummages, E stands
up, D shows her object,
drops it.
B picks up mobilo doll.
E stands as though to

some insects for me. You’re
going to do that OK.
Anything else.

This is for the birthday girl to
sit in. Where’s the birthday girl

It goes outside she says

Should it be there.

Anything else
ChD! ChD! Do you want to
come and help the girls?
Well, thank you. She has. That
must mean she’s a mum. Is that
the mum? Where (emphasised)
shall we put the mum? She’s
going to wait there for someone
to cook the dinner is she.

Right, Child D, where do you
think ChD is going to put
something.

Ooh, what’s that! What is it,
ChD.
It’s bath

Where’s there.

Next to the sink. You think,
next to the sink? Yes at the
side of the sink.

It’s a table. You know what,
we’ve got a table inside. Where
else can we have a table.
How about here. Outside.
In the grass perhaps. (indistinct
conversation with all three)

Right, choose something else.

Ooh, wonder what that is. What
do you think that is supposed to
be. That’s a bit funny, oh!

What else have you got. I think
there’s room for another person
Ch B There
Ch E These will fit. Tall
Ch E He's got (indistinct)
Ch D I know
Ch E That's a good place!
Ch D I know
Ch E Yes
Ch C Mrs A! Can I play with that now?
Ch B Can I play with this, Mrs A?
Child D No
Ch A Mrs a can I play with the scissors?
Ch E He's been naughty!

Do something, then
watches B who moves to dh. B puts doll in
kitchen, stands back. D
reaches into dh with
mobile doll E
rummaging. Picks up
two mobile dolls

D to attic. Ch C comes
over, goes. E smiling,
E overbalances and
falls. Gets up smiling
E and Teacher A laugh.
B turns away. CC
comes over.
A goes away

D turns to A, aggressive
look

B goes off. D moves
objects in attic. E looks
at dolls.
Bangs boy doll up and
down the 'grass'. D
picks up object. Ch C
comes over with
stethoscope. A returns.
Points to hearing end.
Ch C looks blank. A
picks up hearing end
and puts over C's heart.
D makes doll dive
headfirst off attic to
grass. C looks blank. E
and D make dolls meet
on 'grass'.
C shows A the hearing
end, takes off ear
pieces. A points to C's
chest and taps it. C
looks down. A leans
back. D and E playing
with dolls and DH.
A picks up hearing end
and places on C's chest.
C puts on ear pieces. A
looks over to D and E
who are still playing.

Ch C Inside your body.

Ch E He's been naughty
Ch E He's going to get you

Ch D Are you having lunch
over there. He's going to have

in this house. Do you think it's
probably good...
That's it, waiting for dinner.
Where will she sit.
Where's there.

Is he? Sitting on top of the
wardrobe? You know what, he
could hide in there somewhere.
Hide in there.

It is. Got to be careful not to get
stuck though
Are you alright?

Yes alright

To Chd: Ch C wants to listen to
your shoulder! Are you
listening? Where do you put
that to listen.

You put it on your chest for the
beats.

Did you hear the beats? What's
beating
It's your heart making that
sound. Where is your heart?

It's inside your body. Isn't it?

It's inside your body and you
listen to it inside your body.

Ch C do you want to help us in
the dh? Do you want to build up
the dh. Come on then, help us
build the dh.
<table>
<thead>
<tr>
<th>Time</th>
<th>Speaker</th>
<th>Text</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:24:37</td>
<td>ChA</td>
<td>it's the kitchen. There's a table in there an all.</td>
</tr>
<tr>
<td>0:24:37</td>
<td>ChA</td>
<td>Yeees</td>
</tr>
<tr>
<td></td>
<td>ChA</td>
<td>I've got a big table in my house. I've got, I've got....</td>
</tr>
<tr>
<td>0:25:47</td>
<td>ChF</td>
<td>We've got a small table in front of out TV. No mummy and daddy...um...um no children and I just sit there and eat by myself looking at tv.</td>
</tr>
<tr>
<td>0:25:47</td>
<td>ChF</td>
<td>And it's ages til I (indistinct)</td>
</tr>
<tr>
<td>0:26:20</td>
<td>ChF</td>
<td>That. Ch F Yes</td>
</tr>
<tr>
<td>0:26:20</td>
<td>ChF</td>
<td>Hmmm In the kitchen. ChF She's cooking the dinner</td>
</tr>
<tr>
<td>0:27:47</td>
<td>ChF</td>
<td>How many teddy bears, one, two</td>
</tr>
<tr>
<td>0:27:47</td>
<td>ChF</td>
<td>How many we got, one, two</td>
</tr>
<tr>
<td></td>
<td>A and F</td>
<td>turn to box. F picks up mobilo doll. Puts in kitchen on side</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>Points. A looking at object.</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>points into kitchen.</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>shakes head. F reaches inside dh. F points at table</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>points to attic. Points to bedroom. A rests chin on fist. A raises fingers one at a time</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>pointing at bedroom then kitchen</td>
</tr>
<tr>
<td></td>
<td>Teacher</td>
<td>repositioning objects</td>
</tr>
<tr>
<td></td>
<td>F</td>
<td>twisting on heels and pulling at dress, shoulders raised.</td>
</tr>
<tr>
<td></td>
<td>A</td>
<td>leans forward, shakes her head.</td>
</tr>
</tbody>
</table>

Now let's see what rooms we've got. We've still got empty rooms.

Come here, there's some empty rooms. We've got garden chairs to take outside haven't we. What room's this? There is a table.

Have you got a table in your kitchen at home. (to F). Have you?
And where's your table. Have you got a table at home. Some people don't have tables at home, you see.

That's a little bit sad isn't it. It makes me feel a little bit sad. Really, Now what are we going to put inside our house. Look in the box. See what we are going to put in there. What's in the box.
Is that the mummy? Right. Where are we going to put the mummy? What's she doing? She's cooking the dinner. Doesn't she need to stand to cook the dinner? She's cooking. Where does she stand? Where's that? So does she stand on top of the oven? Alright, where does she stand. Ah, she stands next to the oven. Right

OK, we've got one, two, ....

How many children? We've three there, two there

You know, I forget my numbers all the time. Sometimes I forget them all the time and
A I've got this

0:28:06

A A bed

F turns to box

A points to middle of the room.
F smiles. F has object. Teacher takes it.
F takes it back. Tries to open out the deckchair, puts it down. It collapses.

Teacher looks round room. A to box.

Points to writing area. F looks too, smiling. A rummaging.

F I got two!

0:29:17


F they should be in there.

A Dishes

F Cupboard
F Look at this thing!

ChA hands A an object.
F Rummaging.
F stands up, empty-handed.
F rummaging.

F Yes! My one.

Ch A Yeh!
Ch A No

F I got another one!
A That way

A finds carcass of drawers.
F tries to put drawer in carcass. A smiles
A holds out carcass. Ch A unsure. F with second drawer.
A turns drawer round and reinserts.

F This side
A One, two

A anf F OK.

A Looks away, then back, ChA inserting drawers. A looks at house, picks up cooker

Back of the room

Gives to A.
A takes object. Puts it at side of kitchen.

sometimes I remember them it's just crazy. Do you want to see what else is in the box?
Have you now. I could go to sleep on it. Put it in the middle of the floor and I'll go to sleep on it. What is it?
A bed. (To F). Oh! That's a funny thing!
You know what, yeh, you....

It all fell down, doesn't it. Do you think it can stand up properly? Try and make it stand up. That'll be very clever. ChA, can you find something to do, sweetheart, please? Do you want to do some writing letters?
Or, the bugs are over there. (To A and F) You keep on looking. I'll be back in a minute.

Talks to other children.
Computer noisy.

Oh dear these people, they're not alright, are they.
They're too big, aren't they.
These little people...so there are some more in there. They're sweet.
What do you think that could be?
For dishes, Where would they go then?
In the cupboard. But they are in the cupboards already. So where do you think we can put that? Do you think it will go in there?
Do you think that's the right way round? Is it? Open it first.

What we need to do
That way. Shall we see if we can find another one. How many have you got?

How many?
I'm going to put this in the kitchen, girls. OK?
Shall I put it in the front of the room or at the back of the room? Can you put it in the back of the room for me?
Good girl. Is that the... Just a
A At the back of the room.
F Mrs A...
F Mrs A...
A I'll put it...

F Washing machine

A I don't know where that bit is.

F I've got it
F I've found two beds! Mrs A!
A and F Two beds!
A Upstairs

A I'm going to put that one in there
F Mrs A! Mrs A, look this is a cupboard. I found a cupboard.

F Another oven

F errr. Up there!

A You can sit on it.
F I've found a chair and a bath.
F I've found a chair and a bath.
A In the bathroom.
A There
F In there
F I've got a pigtail, look.

Teacher turns house towards A. Taps the cooker.
Touches A to get her attention
Ch A looks unsure. A taps the back of the dh.
Ch A moves cooker to the back.
Looks at F

Distracted by E coming over. Talks to E about washing up. F goes away. A turns and holds up object. F returns. A takes her arm. F points to empty downstairs room. No sign that F is wrong. No response from F.
A puts finger to lips. F puts at the side of the empty downstairs room. A looks at floor.

A looks away, smiles.
A turns back.
Ch A points to attic. A gets up and moves to another group.
Picks up bed from where A has left them.

A returns. Neutral even stern.
F hands up, swinging on heels. A takes hold of F's wrist.
Points to left bedroom
Pints quickly in the direction of the oven. F points to and taps the back of the room.
Holds up deckchair and smiles. A ignores F and puts up deckchair. A holds face. Ch A hands up
Points to empty bedroom
F places bath at back of room. A rummages.
Pulls out doll. Ch A touches doll. A touches Ch A's hair. A touches

minute, look at it.
Is that at the back of the room?
Where is it?
I think...just a minute...I think that's the back. That's the side. Stretch...stretch...stretch. That's better. That looks lovely in there. That's like at home. Now what could that be?
Where should that go?

Come here
Where shall we put it?
In the lefthandside. At the side of the kitchen?
Go on, put it at the side of the kitchen.

Well, you'll have to have a good look for it.

Have you?
What are they?
Where shall we put two beds?
Upstairs. Go on then.

It looks like a cupboard. Hmm. What could have those grey things on top?

Another oven! This is really good house. Where did we put the other oven?
Up there. Go on then. That'll be the second kitchen. Where've you put it? Where've you put it?
The back.
You've got to get it right first.

Where do we put these?
Do we have a bathroom?

At that side.
Ah Look!
Isn't she nice. I like her! Look at her hair! You've got plaits as well. You've got...
F One, two
A This isn’t a....

A Under my television there are buttons....

A Wires

F I’ve got a table.

F I’ve got a table.

A Television room

0:33:55

A looks frustrated.
Shakes TV
Gives to A who puts it in kitchen/bedroom. A takes doll out of the box. Hides in hands.

A smiles. F looks.

Cover’s F’s eyes with hand for a second, then takes away. Hides doll.

Touches F
Interrupted by E

Child A points. F hand flexed above head, ready to point.

Touches F. Interrupted by E. F turns away, looks at table. Ch A still looking. A goes off.

Ch A looking, F looking at table in her hands.

0:34:55

F looks at Ch A

ponytails. How many ponytails?

That’s another.... I wonder what that could be. I know. I thought it was something funny. Do you know what it is? I think it’s a television because... what’s that?

Underneath the television. What’s that under the television. Have you got something under your television?

Under the television.

Wires....
And.... Something I put in there to watch my favourite films...

(Looks at F). What is it? Have you got a recorder or a DVD player.
You’ve got a table. Where should I put this. Television room. Go on.

I’ve got a person, and I’m going to hide this person. Are you ready. Close your eyes. Close your eyes, F. I’m going to hide the tele....I’m going to hide the person.

I’m going to take these ones out. Oh no. It’s a person wearing blue! Ok. I’m going to hide....

Ok eyes open! Where is he?
Where is he hidden?
It’s not that one!

He’s wearing blue. The one in blue. Can you see him? Have a look. Look around. Where is he?

See if you can find him, F! Be back in a minute. If you find him you’ll do really well!
(Doll behind dresser in attic, in children’s reach)
<p>| A Where’s he gone now? | Are you still looking? He’s in there. Shall I give you a clue? What do I look at this in? Where’s the mirror? Where’s that? He was where? He was... Good girl! He was behind the cupboard! I’m going to hide him again! Close your eyes... Close your eyes... OK! Where’s he gone now? Where is he? He’s hiding! Where is he? Where is he? Good girl! Close your eyes! Don’t peek, don’t peek. OK! Where is he? Where was he? Under the cupboard! Right, I think F should have a turn. F, do you want a turn at hiding him? No. Do you want a turn? Go on, then. We’ll close our eyes. |
| 0:37:05 | A I’m not ready! F I don’t want to... A There! |
| F Uh-huh | F shakes head a little. A holds out doll to Ch A who nods and takes doll. A takes F and both cover eyes. Ch A smiles, drops doll, others open eyes as she takes wardrobes. Ch A looks anxious. Then hides doll. F looks uncomfortable. F and A open eyes. F hand to mouth, head down. F moves away. A hooks F round her waist and draws her back. Ch A smiling and excited. F shoulders raised, finger to mouth, smiling. Quick, quick! Can you see? |
| F There! | Oh, where was he? Where was he? I didn’t see! Behind the television he was! Cheeky, isn’t he! Do you want a turn? |
| A Behind the TV | Picks up doll. Looks at F and holds doll out to... |</p>
<table>
<thead>
<tr>
<th>F No.</th>
<th>A No</th>
</tr>
</thead>
<tbody>
<tr>
<td>A Red hair!</td>
<td></td>
</tr>
<tr>
<td>A Nearly look like that.</td>
<td></td>
</tr>
<tr>
<td>A White</td>
<td></td>
</tr>
<tr>
<td>F Eyee, you fix it...</td>
<td></td>
</tr>
<tr>
<td>0:38:22</td>
<td></td>
</tr>
<tr>
<td>A Hey, let’s play! You can be the big sister, yeh? Hello, sister! She’s coming!</td>
<td></td>
</tr>
<tr>
<td>A What are you doing, you lot!</td>
<td></td>
</tr>
<tr>
<td>A F, are you going to play? You say ‘Oh, why?’</td>
<td></td>
</tr>
<tr>
<td>A Dee, dee de de</td>
<td></td>
</tr>
<tr>
<td>A I wish I had my hair like that.</td>
<td></td>
</tr>
<tr>
<td>F I found another cupboard.</td>
<td></td>
</tr>
<tr>
<td>A (to teacher) I’ve got loads of cupboards!</td>
<td></td>
</tr>
<tr>
<td>F (to teacher) Do you know how many I got?</td>
<td></td>
</tr>
<tr>
<td>F Errr....err</td>
<td></td>
</tr>
<tr>
<td>F One and two</td>
<td></td>
</tr>
<tr>
<td>A I’ve got 60.</td>
<td></td>
</tr>
<tr>
<td>A I’ve got a thousand.</td>
<td></td>
</tr>
<tr>
<td>F I got four</td>
<td></td>
</tr>
<tr>
<td>A I’ve got thousands!</td>
<td></td>
</tr>
</tbody>
</table>

<p>| Do you want another turn? |
| What else can we do? |
| I know what we can do. You know this dolly? It’s got stuck up hair, like mine in the morning. Look! (To F) Does he look like me? Do I look like that? Style is the same but what about the colour. What colour is it? White is it... |
| Let’s just check how the others are doing. You keep building up the house. |
| There are lots of cupboards. I wish I had all those cupboards in my house. Have you? |
| How many? How many cupboards have you got? One and two. You’ve got two cupboards. |
| You’ve got thousands! |</p>
<table>
<thead>
<tr>
<th>Time</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>0:41:58</td>
<td><strong>F</strong> I've found another... returns and kneels. Puts hand on F's waist. A emphasises pleased by gently punching air. A looks from Child A to F. A lets go of F. A looks from A to F.</td>
</tr>
<tr>
<td></td>
<td>No eye contact. Ch D restless. A puts fingers to chin.</td>
</tr>
<tr>
<td>0:44:35</td>
<td><strong>Me</strong> interviewing children.</td>
</tr>
<tr>
<td></td>
<td><strong>Child A</strong> A camera With help from A All eye contact but D <strong>Child A</strong> Because we need to learn. Band C Yes D No. <strong>D To learn good stuff!</strong></td>
</tr>
<tr>
<td></td>
<td>You've got a thousand! That's such a huge number! You know what, we can leave this here because I'm very pleased with the work we've done in this house. I think it looks fantastic! You should be really proud of yourself because you've done really good. You have to work really hard to make a really good house. We're going to tidy up quickly because it's tidy up time and time for the carpet. And later... later... you can play.</td>
</tr>
<tr>
<td></td>
<td>One there... and one there... and one there, cue. That's a one thing (to come).</td>
</tr>
<tr>
<td></td>
<td>Who... who... so, when we were playing we were using lots and lots of words, lots of words to position things in our dh.</td>
</tr>
<tr>
<td></td>
<td>Ch D, sit down nicely, please. We were using all the words in the dh. We were putting in (slight emphasis) things, F, me and you (CH A) played hide-and-seek. Inside, behind, under. Lots and lots of words, we use them everyday, all the time. Don't we? We do. Now we are going to get ready for assembly... Child A, would you like to choose a friend to line up next to you....etc for all children.</td>
</tr>
<tr>
<td></td>
<td><strong>Andrea</strong> Well! Do you remember when I came in on Friday I showed you something. Do you remember what I showed you? What did I show you? Yes, with a microphone. Now I've got something to show you. First of all I have to ask you a very difficult question. I think you can answer it. Why do you come to school? That's a difficult one. Yes? Because we need to learn! Is that a good answer? Do you agree? No, D? Why do you come to school? That's fantastic! And you were</td>
</tr>
<tr>
<td>Time</td>
<td>Interview with A</td>
</tr>
<tr>
<td>--------</td>
<td>-----------------------------------------------------------------------------------</td>
</tr>
<tr>
<td>0:55:44</td>
<td>B I know!</td>
</tr>
<tr>
<td></td>
<td>B Umm, we were wanting him this side, and this side and that side and this side.....</td>
</tr>
<tr>
<td></td>
<td>A the inside.</td>
</tr>
<tr>
<td></td>
<td>B On top</td>
</tr>
<tr>
<td></td>
<td>B At the front</td>
</tr>
<tr>
<td></td>
<td>A Back, back.</td>
</tr>
<tr>
<td></td>
<td>B At the back</td>
</tr>
<tr>
<td></td>
<td>Several at the side.</td>
</tr>
<tr>
<td></td>
<td>C At the side, side</td>
</tr>
<tr>
<td></td>
<td>Chorus Yesss</td>
</tr>
<tr>
<td></td>
<td>0:55:44</td>
</tr>
<tr>
<td></td>
<td>C It’s a fun game</td>
</tr>
<tr>
<td></td>
<td>D Nooo</td>
</tr>
<tr>
<td></td>
<td>D Nooo</td>
</tr>
<tr>
<td></td>
<td>C I liked that pictures</td>
</tr>
<tr>
<td></td>
<td>C Somebody’s pulling me.</td>
</tr>
<tr>
<td></td>
<td>C I’m hungry!</td>
</tr>
<tr>
<td></td>
<td>C Yea</td>
</tr>
<tr>
<td></td>
<td>Interview with A</td>
</tr>
<tr>
<td></td>
<td>working with Mrs A this morning, weren’t you. Sitting on the carpet here. And you were learning good stuff. What good stuff were you learning this morning?</td>
</tr>
<tr>
<td></td>
<td>Wow! And how about when you were sitting her with this. What were you learning with Mrs Turner...</td>
</tr>
<tr>
<td></td>
<td>Did you? That’s wonderful! Did you learn anything else? The inside! And.</td>
</tr>
<tr>
<td></td>
<td>Is that the front?</td>
</tr>
<tr>
<td></td>
<td>You think the front or the side? OK. I think you’ve learnt ever such a lot of good stuff. Would you like to see pictures of you learning good stuff? See yourself on television, as it were, would you like that?</td>
</tr>
<tr>
<td></td>
<td>OK. I think you’ve learnt ever such a lot of good stuff. Would you like to see pictures of you learning good stuff? See yourself on television, as it were, would you like that?</td>
</tr>
<tr>
<td></td>
<td>Well, what did you think about seeing youself? It’s a fun game. Do you learn a lot? Do you learn a lot of good things?</td>
</tr>
<tr>
<td></td>
<td>I want to say thank you very much for letting me come... come into your classroom. Soon be lunchtime.</td>
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cxvi18
Appendix N: Sample of mathematical words used during teacher generated input/activity
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<th>Nov/Class 1</th>
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<th>Ch during activity</th>
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<td>1</td>
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<tr>
<td>(on) top</td>
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<td>1</td>
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<tr>
<td>side</td>
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<td>6</td>
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<td>on (not as in 't)</td>
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Other words used:
- numeracy 1
- position 4
- positioning 2
- back 3 8 2 1
- down 1 1
- next 1 5 1
- there 6 10 1 13
- here 3 3 2
- where 3 27
- up 2 3
- under 2 4 2
- underneath 3 1
- somewhere 1
- into 1
- inside 15 6 1
- outside 4 1
- round 1
- downstairs 4 1
- upstairs 3
- middle 8
- bottom 1
- left 3
- lefthandside 1
- behind 2

cxviii
Appendix O: Sample of mathematical words used during teacher generated and group activities
Nov/Class 3
Times Keywords used by

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<th>Teacher</th>
<th>Children</th>
<th>Group 1 SD/Gp1</th>
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<th>Group 3 SD/Gp3</th>
<th>Group 4 JC/Gp 4</th>
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side 3

times 7 2 1 3 1 8 3

and 2 48

repeated addition 7 1 1

subtraction 2

bigger 3 2

putting it together 1

multiplication 3

division 7 1 8 3

number line(s) 2 1 1 1

altogether 2 1 7

makes 1 7

plus 17 5 2 1 7 1

less/lesser 1 1

single 1

downwards 1 1

take away 3 1

equals/equal to 14 1 2 3 6 1 12

is/are 39 will be 2

that's 1 that's 1

first 2

2 x 1

3 x 3 3 3

4 x 1

sum (calc not add) 2

count 7 1 counted 4 2 10

more 1 one more

how many 7 4 6 1 1 5 1 27

scale 3

whole 1

big enough 1

as big 1

bigger 2

centimetres 1

metre 2

same 1 1
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<th>Term</th>
<th>Frequency</th>
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<td>another...on</td>
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<td>amount</td>
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<td>cube</td>
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Appendix P: Shuard and Rothery analyses
Class 1 Word analysis: frequency of key mathematical words/phrases used in discourse

S&R categories: T=technical; L=lexical; E=everyday
T=teacher; Ch=children; dha=doll's house activity; pg=painting; ICT=maths. Program; bugs=bugs sort; mf=model farm; lw=letter writing

<table>
<thead>
<tr>
<th>Times KWS/Ps used by</th>
<th>MV</th>
<th>S&amp;R cat</th>
<th>T class</th>
<th>Ch class</th>
<th>T dha</th>
<th>Ch dha</th>
<th>Ch pg</th>
<th>Ch ICT</th>
<th>Ch bugs</th>
<th>Ch mf</th>
<th>Ch lw</th>
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<td>0</td>
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</tr>
<tr>
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<td>0</td>
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<td>0</td>
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</tr>
<tr>
<td>(on) top</td>
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<tr>
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</table>

Other words used:

- numeracy
- position
- positioning
- back
- down
- next
- up
- under
- underneath
- into
- inside
- outside
- round

<table>
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<tr>
<th>MV</th>
<th>S&amp;R cat</th>
<th>T class</th>
<th>Ch class</th>
<th>T dha</th>
<th>Ch dha</th>
<th>Ch pg</th>
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Class 2 Word analysis: frequency of key mathematical words/phrases used in discourse

S&R categories: T=technical; L=lexical; E=everyday
T=teacher; TA+ Teaching assistant; ch=children

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<th>S&amp;R category</th>
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<th>Children</th>
<th>TA /Gp 1</th>
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**Other words**

<p>| pointy                  | N            | L       | 0        | 0        | 4      | 1      | 0       | 0      | 0      |
| counting               | N            | L       | 2        | 0        | 0      | 0      | 0       | 0      | 0      |
| count                  | Y            | E       | 8        | 0        | 7      | 0      | 8       | 1      | 0      |
| in twos                | N            | L       | 2        | 0        | 0      | 0      | 0       | 0      | 0      |
| go on                  | N            | L       | 1        | 0        | 0      | 0      | 0       | 0      | 0      |
| starting               | N            | L       | 2        | 0        | 0      | 0      | 0       | 0      | 0      |
| all the way to         | N            | L       | 1        | 0        | 0      | 0      | 0       | 0      | 0      |
| backwards              | Y            | L       | 2        | 0        | 0      | 0      | 0       | 0      | 0      |
| shape(s)               | Y            | L       | 68       | 5        | 41     | 6      | 26      | 1      | 2      |
| property(ies)          | N            | E       | 12       | 0        | 0      | 0      | 0       | 0      | 0      |
| 2D                     | Y            | T       | 20       | 2        | 0      | 0      | 0       | 0      | 0      |
| 3D                     | Y            | T       | 16       | 3        | 0      | 0      | 0       | 0      | 0      |
| difference between     | Y            | E       | 1        | 0        | 0      | 0      | 0       | 0      | 0      |
| flat                   | Y            | E       | 8        | 1        | 0      | 0      | 2       | 0      | 0      |
| blown up               | N            | E       | 1        | 1        | 0      | 0      | 0       | 0      | 0      |
| body                   | N            | E       | 1        | 0        | 0      | 0      | 0       | 0      | 0      |
| oblong                 | Y            | T       | 2        | 1        | 5      | 0      | 1       | 2      | 0      |
| box                    | N            | L       | 2        | 1        | 1      | 0      | 0       | 0      | 0      |
| hexagon                | Y            | T       | 6        | 3        | 2      | 0      | 0       | 0      | 0      |
| cuboid                 | Y            | T       | 4        | 2        | 0      | 0      | 3       | 4      | 0      |</p>
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## Class 3 Word analysis: frequency of key mathematical words/phrases used in discourse

**S&R categories:**
- T = technical
- L = lexical
- E = everyday
- T = teacher
- TA = teaching assistant
- Ch = children

### Times KWs/Ps used by

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Appendix Q: School Improvement Partner Autumn Visit Reports (2007) marked up
School Improvement Service

School Improvement Partner

Data Review Visit 1 – Part A – Autumn Term 2007

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<th>School</th>
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<th>SIP</th>
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School Category: Light green

Present at the Meeting: Lyn Fairweather, Richard Pool and Judy Ruff

Date of meeting: 27th September 2007

Purpose of Visit:
- Data discussion – standards and achievement based on pupil outcomes, summer 2007

Foundation Stage
- Attainment on entry to the school is broadly in line with the national average, although the school's size does attract families with children experiencing specific difficulties in the areas of behaviour and delays in language development. The Headteacher reports that this academic year eight children from the cohort of ten live within the village.
- Attainment in Communication, language and literacy [CLL] at the end of the Foundation Stage is below the national sample level (5.5) demonstrating that some Foundation Stage children are having difficulties acquiring language at expected rates.
- The cohort is also very small (9 pupils) so that one child's score has a significant impact on the overall result. For example, one child had only attended school for half a term and scored very low.

Analysis of Foundation Stage Profile
Number of pupils: 9

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- Dispositions and attitudes scored 7.0, indicating that children are eager to learn.
- Social and emotional development scored less well (5.5 and 5.6) under national expectations. Not all children have access to pre-school provision prior to entry into the reception class.
- 'Linking Sounds and Letters', 'Reading' and 'Writing' were all below national expectations, although an improvement on the previous year's scores. The school recognises that a more focused approach to this aspect of learning is required.
- Mathematical development was in line overall with national expectations. However the area of 'Calculation' was significantly the weakest area and will require a focus in the 2007-2008 School Improvement Plan to improve teaching and learning approaches in this aspect.
- Knowledge and Understanding of the World at 5.3 was below national expectations and requires further scrutiny of the way in which this aspect is taught in the reception class.
- Creative development at 5.3 is also a weaker area and under national levels of expectations.
- The accuracy of the Foundation Stage assessments is an area which requires further support through moderation opportunities with practitioners in other settings to compare and discuss the learning opportunities provided and the outcomes from these.
- Physical Development is strong at 6.8. The children have good opportunities to develop these skills through the outdoor curriculum and the use of the school hall facilities on a regular basis.

- Progress from the end of the Foundation Stage in 2005 to the end of Key Stage 1 in 2007 is good.
Standards at the end of Key Stage 1 in 2007

Number of pupils: 7 (Boys: 2, Girls: 5)

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<td>16.1</td>
<td>15.2</td>
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Two points above or below the national average is exceptional

- In reading the school is very close to 2 points above the national levels (-0.3). All pupils assessed attained at L2B. However, there were not as many pupils attaining at L3 (1 girl pupil) as compared with the national and LA levels. The APS of 17.3 placed the school in the second LA quintile.
- In writing, the school made exceptional attainment overall with an APS of 16.4. Again there was a very high percentage of pupils attaining at L2B+ (86%) putting the school in the first quintile for writing at this level. One girl pupil attained at L3.
- In mathematics again the school is very close to being 2 points above the national level (-0.1). Boys slightly outperformed the girls (18.0 to 17.4). More pupils (3) achieved at L3 in mathematics, putting the school in the top quintile of LA performance.

Refer to the Lower School Annex and Raiseonline. Comment on the attainment of specific groups of learners where there are substantial/significant differences, including those of travellers and looked after children.

- There was only one mixed race child in the cohort. This child performed at a very high level across all subjects (21.0).

Grade: 2

Standards at the end of Year 4 in 2007

Number of pupils: 10 (Boys: 4, Girls: 6)

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National age related expectation = 21.0 points

- The APS of 24.4 for reading represents exceptional attainment, 3.4 above the national age related expectation and 1 point above the LA average. The six girls performed at 25.7 (3.2) above the four boys. 60% of pupils attained at L4, placing the school result in the third LA quintile of achievement. There were slightly more girls than boys at this level.
- In writing the result was 0.8 higher than the national age related expectation and 0.2 above the LA average. Two out of the four boys achieved at L4 in writing.
- In mathematics the APS score of 22.1 puts the school at 1.1 above the national age related expectations and 0.3 above the LA average. Boys outperformed the girls by 4.3 points.
- Overall the school's APS of 22.5 was 0.3 above the LA average.

Progress for matched pupils from Year 2 [2005] to Year 4 [2007]

Number of pupils (matched): 10 (Boys: 4, Girls: 6)
### Results and targets (set Autumn 2006)

#### Key Stage 1

Number of pupils included in targets: 7 (1 pupil is equivalent to 14.3 percent)

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- In reading, the actual results surpassed the teacher targets by substantial margins at L2 and L2B. The predicted attainment at L3 was not achieved, but in this case it was the performance of one child that was involved.
- In writing, one child did not attain the L3 expected, but at the other levels there was an improvement on the targets set.
- In mathematics pupils achieved better at L2B than predicted, but one child failed to make the L3 set by teacher targets.

#### Year 4

Number of pupils included in targets: 11 (1 pupil is equivalent to 9.1 percent)

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- In reading targets were being accurate, small amount of difference at L4+.
- In writing pupils did better than teacher targets at L3B+, but particularly at L4+.
- In mathematics pupils again did better than their teacher targets at the higher levels.
• Target setting has improved considerably at the school over the past academic year. Teachers have had the support of external tutors to guide the setting up of effective tracking systems across the school.

Summary grades:
Standards – Key Stage 1 : 2
Standards – Year 4 : 2
Progress from entry into the Key Stage 1 to the end of Year 4 : 2

Signed........................................... Dated..............................................

Email to [REDACTED], Senior Admin Officer
Purpose of the Meeting
1. Review Standards and Achievement 2007 – using pre-populated sheets based on the Lower School Annex and identify areas of underachievement.
2. Confirm the school’s key priorities for improvement 2007/8 where progress will to be tracked with the SIP.
3. In discussion with the Headteacher, identify support that would be of benefit to the school.
4. Discuss the school’s pupil performance targets for Year 2 and Year 4 (2008 + 2009)
5. Review the school’s ability to self evaluate its own strengths and areas for improvement.
6. Make a judgement on the school’s Capacity to Improve.

Standards and Achievement 2007

Summative commentary to refer to Foundation Stage, Year 2 and Year 4

Standards (provide an overview and the rationale behind judgements made)

Foundation Stage
- Standards at the end of the Foundation Stage are below the national sample overall.
- Children currently make satisfactory progress through the reception year, although the school and the SIP believe that more progress is possible. Accordingly it has made the quality of teaching and learning in the Foundation Stage a priority in the School Development Plan.
- Strengths are in ‘Dispositions and Attitudes’, ‘Numbers as labels and for counting’ and in ‘Physical Development’

Year 2
- Attainment at the end of Key Stage 1 is very close to exceptional in reading and mathematics. In writing it is also very good, well above national levels and above that of the LA.
- More pupils (3) attained at L3 in mathematics than in reading and writing, where only one child attained at this level.
- The school’s profile over time is an erratic one, with peaks and troughs, inevitable to a point, because of the very small cohorts. However, the school has now got much improved systems and structures in place to track pupils’ progress and to intervene where necessary.

Year 4
- In 2007 standards achieved are good, in line with national expectations for mathematics and above in writing. In reading the school is significantly above the national expectation levels.
- Two of the boys attained at Level 4 for writing, which was a very good result.
- The school’s attainment at L3+ in reading and mathematics placed it in the second quintile of LA attainment and it was in the third quintile for mathematics.
- Girls do not attain as well as the boys in mathematics, although they are only 0.3 away from national expectations. Boys’ attainment in mathematics was exceptionally high at 25.0
Achievement (provide an overview and the rationale behind judgements made)

Foundation Stage
- Children enter the reception class mainly in line with national expectations. However, the school has attracted families with children experiencing specific difficulties such as autism and speech delays.
- Progress is good in the areas of ‘Dispositions and Attitudes’ and in ‘Physical Development’
- Where progress is less than expected levels the school is confident that it can address these areas in order to accelerate progress for future cohorts. These actions are set out in the School Improvement Plan and will be followed up on future SIP visits.

Year 2
- Pupils in September 2005 entered Key Stage 1 with results significantly higher than the national sample result. However, the school is not confident in the accuracy of these assessments and this continues to be an ongoing area of concern for the school, to be addressed in this year’s SDP.
- The cohort has continued to make good progress across Key Stage 1, with results very high in all three areas.
- Although the cohort is small, the numbers of pupils working at L3 in reading and writing is an area for further school focus.

Year 4
- Progress in reading is very high at 7.2 points, putting the school into the second quintile of achievement. Girls made faster progress than boys (7.7 points).
- Progress in writing and mathematics was just below LA averages. However, these progress scores should be judged in the light of the very high APS scores achieved in Year 2 in 2005 (17.2, 16.4 and 17.7) which overall were significantly above national levels.
- The six girls made slower progress in mathematics (3.3) and this again requires further scrutiny through discussions with the numeracy consultant. The school is part of the ‘Lower Schools’ Count’ project, so there is scope for this aspect to be addressed within the days allocated to the school for this programme.

School’s priorities for 2007/8

Priority 1
To improve the quality of teaching and learning in the Foundation Stage.

Success criteria
- To have accurate, moderated end of Foundation Stage assessments, providing an accurate baseline for entry into Key Stage 1
- The teaching of ‘Calculation’ will be improved and results of assessments will reflect this
- Very clear end of Foundation Stage expectations will be in place for average and above average ability pupils in the areas of reading and writing for entry into the Key Stage 1 class
- Planning systems will be of good quality and activities differentiated appropriately in line with LA good practice

What changes will be made to support the school’s work?
- To provide Foundation Stage consultancy support for moderation and planning particularly
- To link up with other Early Years’ settings for moderation opportunities
- To effectively support and monitor the quality of work of the Foundation Stage teacher in successfully adopting and adapting the agreed systems and structures
- To seek support and guidance from the Numeracy Consultant on the teaching of calculation strategies within the Foundation Stage
Priority 2
To improve assessment systems across the school

Success criteria
- Tracking /Hibernation sheets are an accurate record of where pupils are in terms of attainment and progress on National Curriculum levels
- Planning systems are consistent in Key Stages 1 and 2, provide sufficient challenge for the higher achievers and activities support well the learning intention
- Marking policy is an accurate reflection of best practice agreed. Marking is used to support the pupils in understanding what the next steps in their learning are

What changes will be made to support the school's work?
- Regular Headteacher monitoring to ensure that there is consistency of practice
- Marking policy updated
- Planning regularly scrutinised and pupils' work in books
- Hibernation sheets scrutinised each half term to identify pupils who are not making or exceeding expected rates of progress

Priority 3
To build the leadership capacity within the school

Success criteria
- The Senior teacher is effective in her role and has a clear understanding of her required contribution to raising standards and achievement across the school
- Subject leadership is owned as the responsibility of all teaching staff and a model of curriculum leadership is adopted suitable for a small school with only a few teaching staff
- Opportunities are utilised well for professional development to build the confidence, knowledge and skills of staff, so that they are able to lead on aspects of the school's work

What changes will be made to support the school's work?
- Review current job descriptions
- Discussions take place between staff and governors on an effective model of curriculum leadership
- Aspiring literacy leader is given opportunities to visit/ shadow another literacy leader in another school to learn effective practice and to attend training courses as appropriate
- Performance Management is used effectively to raise staff performance through clear objectives and regular monitoring

It is for the school to determine the nature of support required to enable the priority to be met. The LA is likely to provide additional support for those schools judged to be in either red or amber category.
### Pupil Performance Targets for Year 2 (2008 and 2009)

The following pupil performance targets were provisionally discussed as final targets will be agreed in the latter half of the term.

<table>
<thead>
<tr>
<th>Year</th>
<th>Results/Targets</th>
<th>Reading</th>
<th>Writing</th>
<th>Maths</th>
<th>All Core Subject APS</th>
<th>No. of pupils in year</th>
<th>Onpup %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L2+ %</td>
<td>L2b+ %</td>
<td>L3+ %</td>
<td>APS</td>
<td>L2+ %</td>
<td>L2b+ %</td>
</tr>
<tr>
<td>Targets 2008</td>
<td>Year 2 targets (set Autumn 2006)</td>
<td>100</td>
<td>71</td>
<td>14</td>
<td>15.9</td>
<td>100</td>
<td>71</td>
</tr>
<tr>
<td></td>
<td>Year 2 targets (revised Autumn 2007)</td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td></td>
<td>LA suggested targets 2008</td>
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<tr>
<td>Targets 2009</td>
<td>School targets Year 2 2009</td>
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<tr>
<td></td>
<td>LA suggested targets 2009</td>
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</tbody>
</table>

### Key Stage 2 Targets for Year 4 (2008 and 2009)

<table>
<thead>
<tr>
<th>Year</th>
<th>Results/Targets</th>
<th>Reading</th>
<th>Writing</th>
<th>Maths</th>
<th>All Core Subject APS</th>
<th>No. of pupils in year</th>
<th>Onpup %</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>L3+ %</td>
<td>L3b+ %</td>
<td>L4+ %</td>
<td>APS</td>
<td>L3+ %</td>
<td>L3b+ %</td>
</tr>
<tr>
<td>Targets 2008</td>
<td>Year 4 targets (set Autumn 2006)</td>
<td>66</td>
<td>49</td>
<td>0</td>
<td>19.0</td>
<td>49</td>
<td>49</td>
</tr>
<tr>
<td></td>
<td>Year 4 targets (revised Autumn 2007)</td>
<td></td>
<td></td>
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<td></td>
<td>LA suggested targets 2008</td>
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<tr>
<td>Targets 2009</td>
<td>School targets Year 4 2009</td>
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</tr>
<tr>
<td></td>
<td>LA suggested targets 2009</td>
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</tr>
</tbody>
</table>

### Commentary on Target Setting processes and targets set

- The school Senior Leadership Team has met to collectively discuss and agree the targets.
- The Year 2 targets are above age related expectations and in line with LA targets in reading and mathematics. The writing target given by the LA is very high and the school, taking into consideration, the particular cohort has sensibly adjusted this to be challenging, yet realistic for the pupils.
- The Year 4 cohort was one which performed overall at significantly below national levels in the 2006 Key Stage 1 assessments. In reading, the APS of 13.8 was significantly below national levels.
- The school has drawn close to the six points progress score for reading and in writing it is slightly ahead of the LA target. However, in mathematics, the target has been set much lower. The school should engage in careful tracking and assessment of this cohort in mathematics and challenge themselves to see if more can be achieved.

- Targets for 2009 have not yet been discussed and agreed

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CXL  
Lower School Staff Report 1B Autumn 20
School's ability to self evaluate

Judgement and evidence base

- The Headteacher has been in post for two terms. She has formed a strong partnership with the Governing Body and there is a good level of mutual understanding of what needs to be done to improve the school further.
- A new School Development Plan is being constructed which accurately sets out six areas of priority working for the school.
- The SEF is also to be updated by the Headteacher, as she has now a much clearer understanding of priorities and the school's strengths and weaknesses.
- The school is building up the confidence of the local community with improved standards and facilities.
- Some new housing development within the village is helping pupil numbers to grow.
- The school has recognised the need to build leadership potential amongst the staff and there is good potential for growth in this area.
- The school has a renewed sense of optimism and energy for the future and an increased belief in the potential for further improvement.

Overall Capacity to Improve - Good

- The small numbers of staff enable good opportunities for the whole workforce to engage in debate and discussion on ways in which the school can be further improved. A recent training day is a notable example of staff working together, examining what makes an effective school.
- The new Headteacher has worked hard to produce monitoring systems which are to be implemented across this academic year. These show a good potential to ensure consistency of approach.
- Consultancy support will be also very valuable in enabling the school to improve progress in writing across the school and in supporting the progress of girls in Key Stage 2 in mathematics.

Key actions for the school

- To complete the SDP in a new format with agreed priorities in time for the Governors’ Meeting on October 9th.
- To arrange for visits to schools in line with progressing SDP priorities.
- To book onto relevant CPD opportunities to support SDP priorities.
- To liaise with numeracy consultant on support for mathematics strand of the SDP.
- To update SEF in the light of the SIP visit, adjusting judgements and rewriting in format as agreed. To present this at the Governors’ meeting on October 9th.

School Category confirmed

Yes √ No

Visit 2 (Autumn 2007)
Monday 19th November, 1.30pm
- Headteacher Performance Management
- Light Touch Review of Performance Management Systems
- To confirm pupil performance targets for 2008 and 2009

Visit 3 (Spring 2008)
Wednesday 20th February, 1.30pm
- Self Evaluation
- Progress towards priorities (identified Autumn 2007)
- Progress towards pupil performance targets
- Impact on pupil progress of support from within or outside the school (evidence based)
- On-going review of actions/support that will help the school to improve
- Quality of learners’ personal development and well-being, including meeting the five ECM outcomes.

Signed: .................................................. Dated: ..................................................

Email to Senior Admin Officer

................................... Lower School Visit Report 1B Autumn 20
Appendix R: Extracts from School Ofsted reports March 2003 and January 2008
SUMMARY OF THE INSPECTION REPORT

LOWER SCHOOL

Acting Headteacher:

Date of inspection: 10th – 13th February 2003

The school was inspected by three inspectors, led by [Redacted]. This is a summary of the inspection report, which is available from the school.

INFORMATION ABOUT THE SCHOOL

Cotton End Lower is a small village school situated just outside the town of Bedford. About 40 per cent of pupils come from the village, the remaining pupils coming from nearby Shortstown and Bedford. There are 61 boys and girls, aged 4 – 9 years old, organised into three classes. The reception class has eight children who attend full time and eight in the afternoon, five of whom have just had their fourth birthday. Overall pupils’ attainment when they start school is average. Eleven pupils, a below average proportion, are identified as having special educational needs for a variety of behavioural and learning difficulties. None have a statement. Nearly all pupils are from white UK heritage. Ten are from other white or of dual heritage. All pupils speak English as their mother tongue. Eleven pupils are eligible for free school meals, which is about average. Pupils come from a range of social backgrounds, which are broadly average. The school is part of an Education Action Zone (EAZ) set up to improve standards in a group of local schools. There has been significant turnover of staff and considerable disruption in the school’s leadership and management since the previous inspection. The governing body has been unsuccessful in finding a permanent replacement for the previous headteacher who left in July 2002.

HOW GOOD THE SCHOOL IS

The school is currently giving its pupils an acceptable standard of education. Under the very good leadership of the seconded headteacher and senior teacher, both of whom are part-time, the school is now building effectively on the changes introduced by the previous headteacher who was in post for one term. Standards and achievement are satisfactory overall. Standards in reading, writing and mathematics are improving in Years 1, 2 and 3. There are weaknesses in the standards of basic skills, information and communication technology (ICT), and geography. Teaching is satisfactory overall but teachers do not expect enough from pupils in their work and behaviour. The use of assessment to match tasks to individual needs is unsatisfactory across the school. Monitoring of teaching and learning is now in place, but there has not been time for the recent planned improvements to result in improved teaching and learning in some subjects and classes. Governors give satisfactory support to the school and are beginning to be more involved in the school’s strategic development. The school is giving satisfactory value for money.

What the school does well

- The acting headteacher and senior teacher, both recently appointed, give very strong leadership.
- Provision for pupils’ social development is good and this means that relationships are good, and most pupils are developing good levels of respect for the feelings and values of others.
- The new governing body knows the school well and is getting to grips with the issues. It has a strong commitment to make the school ‘parents first choice’.
- Pupils enjoy coming to school and attendance is very good.

What could be improved

- Standards in mathematics and writing in Year 4, and in ICT and geography across the school are below average.
- Standards in speaking, handwriting and spelling are not high enough.
- The school does not evaluate effectively how well it is doing.

The areas for improvement will form the basis of the governors’ action plan.

HOW THE SCHOOL HAS IMPROVED SINCE ITS LAST INSPECTION

Improvement since the previous inspection in 1997 is unsatisfactory because the school has not tackled the key issues or many of the weaknesses identified in the previous report. Over the last two years, although standards in reading, writing and mathematics have risen by the age of nine, they have not been sustained this year in writing and mathematics in Year 4. Standards in ICT and geography are worse. No judgement was made about standards in PE, but pupils’ attitudes in the one lesson seen were unsatisfactory, as was the case in the previous inspection, and resources for the subject remain unsatisfactory. The weaknesses in leadership and management have started to be addressed but this is a very recent development, and although there is a detailed management plan there has been little time for the acting headteacher and senior teacher to implement this. Co-ordinators provide poor leadership and management in their subjects because they have been given no opportunity to fulfil their role. The governing body is now much stronger and shows a determination to improve the quality of education for pupils.
STANDARDS

The table shows the standards achieved by pupils at the end of Year 2 based on National Curriculum test results.

<table>
<thead>
<tr>
<th>Performance in:</th>
<th>compared with</th>
<th>all schools</th>
<th>similar schools</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2000</td>
<td>2001</td>
<td>2002</td>
</tr>
<tr>
<td>Reading</td>
<td>C</td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>Writing</td>
<td>E</td>
<td>E</td>
<td>C</td>
</tr>
<tr>
<td>Mathematics</td>
<td>E</td>
<td>D</td>
<td>E</td>
</tr>
</tbody>
</table>

Key
well above average A
above average B
average C
below average D
well below average E

Children start school with average levels in most areas of learning. Their personal, social and emotional development, and speaking and listening skills are better than average. Their knowledge of letter sounds and mathematical language is not as good as some children. They make satisfactory progress in the reception class and, by the time they start Year 1, most are attaining the early learning goals, the expected levels, in all areas of learning. Their social development is better than these.

Because of the school's size, it has smaller than average year groups. Therefore analysis of the school's National Curriculum test results is not always reliable. There were 15 Year 2 pupils who took the tests in 2002 and this number is just about big enough for a secure analysis to give a guide on the school's performance. Results indicate that standards in reading and writing were average when compared to all schools nationally, and well above average when compared to schools with similar number of pupils eligible for free school meals. Standards in mathematics were well below the national average and below average for similar schools. This is because higher attaining pupils did not do as well as they should. Standards seen during the inspection support these results in reading and writing, although there are weaknesses in handwriting and spelling skills. Steps have been taken to improve standards in mathematics, and changes to the curriculum, teaching and learning are ensuring that this year results are likely to be average. Standards in speaking and listening are average. Standards in science are average, and although they are slightly lower than the above average results noted in teacher assessments in 2002, achievement is satisfactory. Overall, achievement is satisfactory in reading, writing, mathematics and science, but unsatisfactory in speaking skills.

By the end of Year 4, standards are average in reading and speaking and listening. They are below average in mathematics and writing. This is because teaching in the mixed Year 3/4 class is not expecting enough of the oldest pupils and work is not sufficiently challenging. Year 3 pupils are doing much better and are attaining average standards. However, poor handwriting and careless spelling and punctuation are evident in much of the work. Standards in science are average. Pupils with special educational needs are supported suitably in most lessons so that they make similar satisfactory progress overall. Achievement is satisfactory in reading and science but although satisfactory for Year 3 pupils, is unsatisfactory in mathematics and writing in Year 4. Achievement in speaking skills is unsatisfactory in both year groups.

Standards in ICT and geography are below average. This is because of weaknesses in curriculum planning, and in teachers' subject knowledge and expertise. A lack of emphasis on developing literacy and numeracy skills in many lessons means that there are weaknesses in pupils' use of these skills in other subjects. No judgement was made about standards in PE and music, as too little teaching was seen and there was no other evidence available during the inspection. Standards and achievement in other subjects are satisfactory.

PUPILS' ATTITUDES AND VALUES

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Attitudes to the school</td>
<td>Satisfactory. Children in the reception class have good attitudes and come to school ready to learn. Most pupils like coming to school and are interested in many lessons. Work is not presented carefully enough.</td>
</tr>
<tr>
<td>Behaviour, in and out of classrooms</td>
<td>Satisfactory overall with some poor behaviour in some lessons by a few older pupils with behavioural difficulties associated with their special educational needs. On occasion, this has a negative impact on the behaviour of other pupils in the class with the potential to misbehave.</td>
</tr>
<tr>
<td>Personal development and relationships</td>
<td>Satisfactory. Pupils enjoy taking responsibility when they are given the chance. They work well together on group collaborative tasks. Relationships are good and pupils have a good respect for the feelings and values of others.</td>
</tr>
<tr>
<td>Attendance</td>
<td>Very good. Pupils attend regularly and arrive at school on time.</td>
</tr>
</tbody>
</table>
TEACHING AND LEARNING

<table>
<thead>
<tr>
<th>Teaching of pupils in:</th>
<th>Nursery and Reception</th>
<th>Years 1 – 2</th>
<th>Years 3 – 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quality of teaching</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
<td>Satisfactory</td>
</tr>
</tbody>
</table>

Inspectors make judgements about teaching in the range: excellent; very good; good; satisfactory; unsatisfactory; poor; very poor. 'Satisfactory' means that the teaching is adequate and strengths outweigh weaknesses.

The quality of teaching is satisfactory overall. Good teaching was seen in all classes and most teaching seen was satisfactory. However, examination of pupils’ work indicates that it is only this term that all teachers have expected enough of their pupils. Assessment information is not used effectively, so pupils often do the same work, whatever their ability, and the needs of higher attaining pupils have not been catered for. Targets have recently been introduced but are not being used consistently to give pupils a clear knowledge of their own learning and what they need to do next to improve. Marking is conscientiously completed, but rarely gives guidance or challenges thinking. The quality of individual education plans for pupils with special educational needs is inconsistent. Clearly detailed targets and support in Years 1 and 2 give suitable guidance to learning support assistants, so that they can ensure that pupils’ specific learning needs are met in lessons. However, these are not yet precise enough for some pupils in Years 3 and 4. Consequently, there is still inconsistent use of behaviour management strategies, which is giving mixed messages to pupils with behavioural difficulties.

Literacy and numeracy skills are taught satisfactorily overall, although there are weaknesses in the development of speaking and writing in other subjects. Not enough emphasis is placed on developing presentation skills and expecting appropriate levels of spelling. Pupils in Year 4 are not being challenged enough in mathematics so have not made satisfactory progress this year. Teaching of ICT is unsatisfactory. Because teachers lack the subject knowledge and expertise, they do not develop pupils’ skills or use ICT to support learning in other subjects. Teaching and learning in geography are unsatisfactory because there is too little emphasis on developing skills. No judgement was made about the quality of teaching and learning in music and PE.

Teaching is improving in other subjects and pupils enjoy the variety these provide. There is clear planning to develop pupils’ subject knowledge but specific skills are not yet planned sufficiently well in all subjects. As a result of recent monitoring, learning objectives are clearly identified in planning and these are matched closely to schemes of work. This is leading to interesting lessons when pupils are motivated, and they concentrate well as a result. Homework is unsatisfactory in Years 3 and 4 as it often focuses on pupils finishing off work not completed in lessons.

OTHER ASPECTS OF THE SCHOOL

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>The quality and range of the curriculum</td>
<td>Satisfactory overall. Some lessons are too long and aspects of some subjects are not taught regularly enough. Due to weaknesses in provision for ICT, the curriculum does not meet statutory requirements. Visits and visitors make a suitable contribution.</td>
</tr>
<tr>
<td>Provision for pupils with special educational needs</td>
<td>Satisfactory. Pupils receive suitable support in lessons with their reading skills. One or two pupils are not always included in activities because behaviour management strategies are not consistently used. Parents are not yet involved fully enough in the review of their child’s individual education plans.</td>
</tr>
<tr>
<td>Provision for pupils’ personal, including spiritual, moral, social and cultural development</td>
<td>Provision for spiritual, moral and cultural development is satisfactory. Provision for social development is good, and this is leading to good relationships and good levels of respect for others’ feelings, particularly at playtimes.</td>
</tr>
<tr>
<td>How well the school cares for its pupils</td>
<td>There is good care for the pupils’ welfare and safety. Assessment procedures and their use are unsatisfactory. Procedures for promoting good behaviour are unsatisfactory due to inconsistent behaviour management by staff.</td>
</tr>
</tbody>
</table>

Parents have positive views of the school and support their child’s learning fairly well. The school has satisfactory links with parents and provides a satisfactory amount and quality of information.
HOW WELL THE SCHOOL IS LED AND MANAGED

<table>
<thead>
<tr>
<th>Aspect</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Leadership and management by the headteacher and other key staff</td>
<td>The acting headteacher and senior teacher give very good leadership. The new management plan is detailed and outlines clearly appropriate priorities for improvement. They have not had enough time to implement this fully so it is not yet as effective as it could be. Subject coordinators give poor leadership and management.</td>
</tr>
<tr>
<td>How well the governors fulfil their responsibilities</td>
<td>The governing body gives good support to the school. Under the new headteacher, there is renewed commitment to improve and the new chair is creating an effective team of governors.</td>
</tr>
<tr>
<td>The school’s evaluation of its performance</td>
<td>Poor. The school has only recently begun to evaluate its performance in a structured and rigorous way. Performance management procedures are not in place and do not support the development of teaching enough.</td>
</tr>
<tr>
<td>The strategic use of resources</td>
<td>Satisfactory, because the acting headteacher has taken urgent action to establish secure financial procedures. Best value principles are not applied.</td>
</tr>
</tbody>
</table>

Staffing levels are satisfactory overall, although the above average number of support staff are not used effectively. Resources remain unsatisfactory, as there are deficiencies in many areas, particularly ICT and PE. Accommodation is unsatisfactory. The reception classroom is too small and does not allow immediate access to the outdoor area, so this is not used effectively as a learning resource. The hall is small and cluttered and this affects provision for PE.

PARENTS’ AND CARERS’ VIEWS OF THE SCHOOL

<table>
<thead>
<tr>
<th>What pleases parents most</th>
<th>What parents would like to see improved</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Most parents agree that their child likes school and are making good progress.</td>
<td>• Many feel that there is not an interesting range of activities outside lessons.</td>
</tr>
<tr>
<td>• Many parents feel behaviour in school is good and it is helping their child to become mature and responsible.</td>
<td>• Some parents feel the school is not well led and managed.</td>
</tr>
<tr>
<td>• Most parents think teaching is good and they all think the school expects their child to do their best.</td>
<td>• Many parents think their child does not get the right amount of work to do at home.</td>
</tr>
<tr>
<td>• Most parents feel comfortable about approaching the school with questions and concerns.</td>
<td>• Many parents feel they are not informed well enough about how their child is getting on and that the school does not work closely with them.</td>
</tr>
</tbody>
</table>

The inspection team does not fully support parents’ positive views of the school. Behaviour in school is satisfactory. Pupils like coming to school and most make satisfactory progress. Teaching is satisfactory and expectations are not high enough. The inspection team agrees that there are not enough activities outside lessons. Leadership and management until recently have been unsatisfactory. Homework in Years 3 and 4 does not always support learning in lessons as well as it should. However, parents receive satisfactory information about the school and how well their children are getting on.

OTHER INFORMATION

The governing body is responsible for drawing up an action plan within 40 days of receiving the inspection report, showing how the school will tackle the improvements needed. This action plan will be circulated to all parents at the school.

The contractor appointed by OFSTED for this inspection was Evenlode Associates Ltd, 6 Abbey Close, Alcester, Warwickshire. B49 5QW.

Any comments, concerns or complaints about the inspection or the report should be made to the inspection contractor. Complaints which are not satisfactorily resolved by the contractor should be raised with OFSTED by writing to: The Complaints Manager, Inspection Quality Division, The Office for Standards in Education, Alexandra House, 33 Kingsway, London WC2B 6SE.

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### Lower School

**Inspection report**

| Unique Reference Number   | 10
| Local Authority           | [Redacted]
| Inspection number         | [Redacted]
| Inspection date           | 5 December 2007
| Reporting inspector       | [Redacted]

This inspection of the school was carried out under section 5 of the Education Act 2005.

| Type of school         | First
| School category        | Community
| Age range of pupils    | 4 - 9
| Gender of pupils       | Mixed
| Number on roll School  | 40

| Appropriate authority  | The governing body
| Chair                  | [Redacted]
| Headteacher            | [Redacted]
| Date of previous school inspection | 10 February 2003

| School address         | [Redacted]
| Telephone number       | [Redacted]
| Fax number             | [Redacted]

**Age group** 4 - 9  
**Inspection date** 5 December 2007  
**Inspection number** [Redacted]
Introduction

The inspection was carried out by one Additional Inspector.

Description of the school

Most of the pupils in this very small school are from White British backgrounds and almost all have English as their first language. The proportion entitled to free school meals, and that of pupils with learning difficulties and/or disabilities, are similar to the national average. The proportion with statements of special educational need is above the national average. More pupils leave or join during their school career than is usual for first schools. Attainment on entry to the Reception class varies considerably from year to year because the cohorts are so small. In some years it has been well above national expectations, in others well below, and there is no consistent pattern.

The school had experienced a lengthy period of disruption in staffing and leadership and management for some years, until the appointment of the present headteacher in January 2007.

Key for inspection grades

<table>
<thead>
<tr>
<th>Grade 1</th>
<th>Outstanding</th>
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<tbody>
<tr>
<td>Grade 2</td>
<td>Good</td>
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<tr>
<td>Grade 3</td>
<td>Satisfactory</td>
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<tr>
<td>Grade 4</td>
<td>Inadequate</td>
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</tbody>
</table>
Overall effectiveness of the school

Grade: 3

This satisfactory school has improved considerably over the past year; the good leadership and management of the headteacher have been instrumental in bringing stability, purpose and consistency. Almost all parents agree; comments such as 'the school has improved hugely,' the present headteacher 'has improved Cotton End 100% in all aspects, teaching, community, children's confidence, working closely with parents,' were typical of a number. Through rigorous evaluation of its effectiveness, she has a good understanding of its strengths and where improvement is needed. The staff are working as a closer team, although their leadership and management skills are at an early stage of development. The governors contribute well to the good capacity to improve further. The school provides satisfactory value for money. Teaching and learning are satisfactory, with strengths in Key Stage 2. Relationships are good throughout the school, between pupils and with adults, and therefore lessons proceed without disruption. Where the teaching is vibrant and engaging, the pupils are totally involved and eager to contribute. The introduction of frequent and regular assessment of pupils' standards and progress is having a positive impact on classroom practice. Teachers are starting to use this information to plan work for their pupils. However, this process is still inconsistent and therefore some pupils, particularly the more able, do not always have tasks that meet their needs. Therefore, they do not make as much progress as they could.

Nevertheless, pupils' achievement is satisfactory; they make sound progress through the school and standards at the end of Years 2 and 4 reflect their attainment on entry. For example, the standards of the children who entered the Reception class in 2005 were well above those expected for their age. Assessments of those pupils' attainment in English, mathematics and science at the end of Year 2 in 2007 were well above average. However, from Reception onwards, pupils do not make sufficient progress in writing. They enjoy their time in school, particularly the developing range of extra-curricular activities and greater use of visits and visitors to enrich the curriculum. While the curriculum is satisfactory, there are too few opportunities for pupils to use and enhance their writing skills in all subjects. The school has identified that links between subjects have not been developed as well, or as imaginatively, as they could be. There is insufficient focus on improving the pupils' skills in each subject.

The school takes good care of the pupils' physical and emotional needs and they say that adults will help them if they need some support. Academic guidance is satisfactory and pupils have targets for improving their work, which they know and understand. These are helping them to see how well they are doing. Pupils have a sound understanding of how to live a healthy lifestyle but this is not always reflected in the contents of their lunchboxes. Their attendance is satisfactory; in spite of the school's best efforts, a few parents do not ensure that their children come to school regularly. Pupils behave well. They say that there is little bullying and that teachers will sort out any aggression if it occurs. Pupils are thoughtful and take responsibilities with enthusiasm when given them but they do not have the opportunity to develop their independence well enough. Nevertheless, they are prepared soundly for the next stage in their education and their future lives.
Effectiveness of the Foundation Stage

The children in the Reception class make a satisfactory start to their education; the adults who work with them have an adequate understanding of their needs. They provide an environment with a range of resources and activities that are mostly appropriate for their needs. Children develop their personal and social skills soundly; they learn the routines of the class quickly and learn to share and take turns. There is an adequate balance of activities that adults lead and those that the children choose for themselves. However, too few activities allow them to develop their independence. Adults devise some interesting ways to stimulate and involve children but do not always design these to sustain their interest or to promote further exploration. Consequently, although the children mainly behave well, they sometimes lose concentration and do not persist with the activities for any length of time. While there is some challenge for the more able, this is not sustained and there is too little that will promote the development of their writing skills. While children make adequate progress overall, some aspects of mathematical development, particularly calculating, are not catered for well enough. There are insufficient information and communication technology (ICT) resources for them to develop their skills.

What the school should do to improve further

- Build on the work already done to develop teaching, especially to cater for the full range of age and ability in the class, so that pupils’ progress, particularly that of the more able, improves.
- Ensure that pupils make good progress throughout the school in writing, and that they develop their skills well through the whole curriculum.
- Develop the leadership and management skills of all staff, so that they take full responsibility for standards in their subjects.
- Develop cross-curricular links, and focus more clearly on developing the pupils’ specific skills in each subject.

A small proportion of schools whose overall efficiency is judged satisfactory but have areas of underperformance will receive a monitoring visit by an Ofsted inspector before their next section 5 inspection.

Achievement and standards

Because children’s attainment on entry varies considerably from year to year, standards at the end of Years 2 and 4 also vary. In all year groups, there is a wide range of attainment and ability. In 2007, the results of the national assessments at the end of Year 2 were well above average, but these were well below average in 2006. The attainment of the pupils who left at the end of Year 4 in 2007 was above that expected for their age, while the pupils presently in Year 4 are working at a much lower level. While achievement is satisfactory overall, it is not good enough in writing and pupils do not form their letters or present their work well enough. Pupils with learning difficulties and/or disabilities and those whose first language is not English make satisfactory progress.
Personal development and well-being

Grade: 3

Pupils' spiritual, moral, social and cultural development is satisfactory. Because the school has a consistent approach to, and high expectations of, discipline, pupils have a good awareness of right and wrong and a keen sense of fairness. Their spiritual and cultural development is satisfactory. Their sound understanding of how to stay safe is reflected in their behaviour. Pupils make a satisfactory contribution to the community, mainly through contributions to charity and connections with local churches and organisations. The school council has not yet started work this year.

Quality of provision

Teaching and learning

Grade: 3

Teachers' planning is consistent and usually shows what pupils are to learn from the lesson. These aims are usually shared with pupils so that they have a clear understanding of the purpose. In the better lessons, pupils are reminded of the intentions and are asked to evaluate how well they have achieved them. These lessons also demonstrate a good match of the tasks to the pupils' abilities and need. The teacher has high expectations of their achievement but there are inconsistencies between classes. In addition, there is an over-use of worksheets in many subjects so that pupils do not practise their writing or set out their own work. Teaching assistants make a satisfactory contribution to the work of the pupils they support but their time is not always used effectively at the beginning and end of lessons. At times there are too many adults in classrooms so that pupils do not have the opportunity to work independently. As one said, 'I'd like to be left on my own and not have someone asking me if I need help.'

Curriculum and other activities

Grade: 3

The school has adopted the new national guidelines for English and mathematics with enthusiasm and this is supporting the development of consistency in teaching. Although the curriculum meets legal requirements, there are imbalances in the timetable, which has many short sessions in addition to the main lessons. Some subjects are not given sufficient emphasis, such as design and technology in Key Stages 1 and 2, or ICT in the Foundation Stage.

Care, guidance and support

Grade: 3

All the required safeguarding procedures are in place and the school carries out all the necessary risk assessments. There is satisfactory support for pupils with learning difficulties and/or disabilities and their individual plans show precisely what they need to improve. The guidance pupils receive through teachers' marking is inconsistent; some books have sound comments, showing how well they have fulfilled the purpose of the lesson and what they need to do to improve further. Occasionally they refer to the pupils' own targets.
Leadership and management

Grade: 3

The headteacher has high expectations for the school and a single-minded determination to bring about the necessary improvements. She has worked hard to develop the understanding of the staff and pupils about the changes that are necessary and the reasons for them. Challenging targets are set for the whole school and for each class, and these are increasingly effective in raising standards. Governors have a good understanding of the school and are active in supporting it and holding it to account. Although there has been satisfactory improvement since the last inspection, it has been very rapid in the past year.
## Inspection judgements

**Key to judgements**: grade 1 is outstanding, grade 2 good, grade 3 satisfactory, and grade 4 inadequate.

<table>
<thead>
<tr>
<th>School Overall</th>
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<tbody>
<tr>
<td>3</td>
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</table>

### Overall effectiveness

**How effective, efficient and inclusive is the provision of education, integrated care and any extended services in meeting the needs of learners?**

- Effective steps have been taken to promote improvement since the last inspection
  - **Yes**
- How well does the school work in partnership with others to promote learners' well-being?
  - **2**
- The effectiveness of the Foundation Stage
  - **3**
- The effectiveness of boarding provision
  - **2**
- The capacity to make any necessary improvements
  - **2**

### Achievement and standards

**How well do learners achieve?**

- The standards reached by learners
  - **3**
- How well learners make progress, taking account of any significant variations between groups of learners
  - **3**
- How well learners with learning difficulties and disabilities make progress
  - **3**

### Personal development and well-being

**How good is the overall personal development and well-being of the learners?**

- The extent of learners' spiritual, moral, social and cultural development
  - **3**
- The extent to which learners adopt healthy lifestyles
  - **3**
- The extent to which learners adopt safe practices
  - **2**
- How well learners enjoy their education
  - **2**
- The attendance of learners
  - **3**
- The behaviour of learners
  - **2**
- The extent to which learners make a positive contribution to the community
  - **3**
- How well learners develop workplace and other skills that will contribute to their future economic well-being
  - **3**

### The quality of provision

**How effective are teaching and learning in meeting the full range of learners' needs?**

- **3**
**How well do the curriculum and other activities meet the range of needs and interests of learners?**

- **3**
**How well are learners cared for, guided and supported?**

- **3**

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1 Grade 1 - Exceptionally and consistently high; Grade 2 - Generally above average with none significantly below average; Grade 3 - Broadly average to below average; Grade 4 - Exceptionally low.
### Leadership and management

<table>
<thead>
<tr>
<th>Question</th>
<th>Score</th>
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<tbody>
<tr>
<td>How effective are leadership and management in raising achievement and supporting all learners?</td>
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<tr>
<td>How effectively leaders and managers at all levels set clear direction leading to improvement and promote high quality of care and education</td>
<td>3</td>
</tr>
<tr>
<td>How effectively leaders and managers use challenging targets to raise standards</td>
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<tr>
<td>The effectiveness of the school’s self-evaluation</td>
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</tr>
<tr>
<td>How well equality of opportunity is promoted and discrimination tackled so that all learners achieve as well as they can</td>
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<tr>
<td>How effectively and efficiently resources, including staff, are deployed to achieve value for money</td>
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</tr>
<tr>
<td>The extent to which governors and other supervisory boards discharge their responsibilities</td>
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<tr>
<td>Do procedures for safeguarding learners meet current government requirements?</td>
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<tr>
<td>Does this school require special measures?</td>
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<tr>
<td>Does this school require a notice to improve?</td>
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Appendix S: Examples of utterance intention data and charts
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<tr>
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<td>CM/P</td>
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<td>0</td>
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<tr>
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<td>CM/M</td>
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<td>0</td>
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<td>Peer /peer</td>
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<td>1</td>
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</tr>
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<td>CD</td>
<td>2</td>
<td>3</td>
</tr>
</tbody>
</table>
Appendix T: Examples of lesson plans and related children's worksheets
LESSON PLAN

SUBJECT: Numeracy

DATE/TIME: 20th November 2006 / 9.20-10.20am

YEAR GROUP: 1 and 2

VENUE: Classroom

CLASS PROFILE:
Total number of children: 16
Number of SEN: 2
EAL: 1

SUPPORT:
Support staff to work with less able group.
During plenary, less able to sit at the edge of the carpet with support teacher.
More able to work as a group.

ORAL MENTAL STARTER 1 (5mins)
CHILDREN ON CARPET AREA
OBJECTIVE
To count forwards and backwards in 1's and 2's to 20.
SUCCESS CRITERIA:
We can count forwards and backwards in 1's and 2's from 20.

ORAL MENTAL ACTIVITY:
Count as a group
Have 100 squares to support less able

MAIN LESSON OBJECTIVE:
1. To recognise the properties of 2d and 3d shapes.

SUCCESS CRITERIA:
We know the properties of 2d and 3d shapes.

LESSON CONTENT AND ACTIVITIES:
Main teaching- introduction (15-20mins)
BRAIN GYM RELATING TO SHAPE AS WHEN REQUIRED
- Tell children the objective and the success criteria.
- What is the difference between them? (explain 2D as flat and 3D as having a body)
  - What do I mean by 'properties'? Explain that we use properties to describe the shape.
  - Show them a cuboid. What shape is it? Is it 3D or 2D? Can they help me label the
    properties?
    - (Side/edge, face, corner/point, base)
  - Show the children a variety of 2D shapes on IWB. Can they recognize the properties?
  - How then some 3D shapes. Do they know the properties of these?
  - Play Venn diagram game. Children to help sort the shapes according to their properties.
  - Tell the children what they will be doing.
  - Refer to timing and expectations.

Main activity (independent work) (15mins)
Differentiated shape work.
Group 1- To sort 3d shapes into Venn diagrams. Working as a group. Have a few unfamiliar
3D shapes. Include a Venn diagram involving right angles. Do they remember what a right
angle is?

Group 2- Identify properties of 3d shapes using shape work sheets and actual shapes that
fold out. Children to have shape vocab to support them.

Group 3- Draw around 2D shapes, name them and list their properties. Children to have
shape cards and names to support them.

Plenary: (10mins)
Children to sit on the carpet
- Address any misconceptions and refer to success criteria.
- What are the properties we have learnt?
- Play guess the shape game on coxhoe http://www.ngfl-
cymru.org.uk/vtc/ngfl/maths/maerdy_2d/frames.asp

EXTENTION WORK:
Group 1 and 2
Build shapes with click.
Make 2d shapes with bands and boards.

RESOURCES/EQUIPMENT:
Shapes 2d and 3d
Vocabulary support sheets
PP presentation
Guess shape game on IWB
Venn diagram game on IWB
Venn diagram sheets / blue tack/scissors
3d shape sort work sheets
math's books for LA
shape click for extra activity
elastic bands and boards for extra activity.

**Vocabulary:**
- Sphere
- Cube
- Cuboid
- Cone
- Triangular prism
- Pyramid
- Cylinder
- Square
- Circle
- Triangle
- Hexagon
- Pentagon
- Oblong
- Face, edge, side, point, corner, base

**ASSESSMENT/REVIEW OF LESSON:**
Good boy!
I am called a cylinder.

I have 2 edges.

I have 3 faces.
I am called a \textit{cuboid}.

I have 12 \textit{edges}.

I have 6 \textit{faces}.

I have 8 \textit{corners}.
Venn diagram

4 or more corners

curved side(s)
November 2006 Class 3
**Learning Intention:**

To revise knowledge of multiplying and dividing and how they are used. To use repeated addition and subtraction to find answers in my work.

**Success Tips**

To add the same number each time to produce a table. (grp 1 and 2)
To use repeated subtraction to check multiplication calculations

<table>
<thead>
<tr>
<th>Key vocab: multiply, divide, add, subtract, repeated, tables, calculate, find, Array, groups, sets</th>
<th>ICT:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Key question: How can division be used to help with multiplication</td>
<td></td>
</tr>
</tbody>
</table>

**Resources:** pencils, worksheet, workbooks, Maths equipment, numberlines

**Context:** This is the introduction to a one-week numeracy unit of work on multiplication and division. It is also the time the subject has been covered this academic year.

**Timing**

| 9.30-9.35 |
| Whole Class Teaching: |
| Introduction |

| 9.40 |
| Mental/Oral |
| Explain that we are going play a doubles game. I will say a number between 1 and 50 chn are to double say the answer |

| 9.45-9.50 |
| Introduction. Write on board $2 + 2 + 2 + 2 = 8$. Ask is there another way this could be written? Complete for other numbers increase the value of numbers each time (4 plus 4 etc) each time. Choose the one of the multiplications and ask how they could check the answer. Give example 2x4=8 can be checked by using repeated subtraction 8-2-2-2-2= is written as 8 divided by 2 Explain that they are going to use repeated addition and subtraction in their work today |

**Main Activity:** (includes differentiation)

- Can working in ability groups to complete task.
- Group 1 complete worksheet 'multiplication and division working with a partner (challenging numbers)'
- Group 2 same activity but smaller numbers(T)
- Group 3 working in books adding 2 each time to create 2 times table to 12 then writing as times table
- Group 4 Working in books same task as group 3 but supported by Mrs Cox

**Groups**

- Groups 1 and 2 use numberlines
- Groups 3 and 4 using counting apparatus to support activity

10:20

- Draw an array on the board for children to guess the multiplication. If time do another explain to this is called an array where the dots represent a number and the columns and rows also represent the times table. Refer back to learning intention - ask children how far they feel that they have achieved this. Children to vote - put up hands to 'traffic light' - eg green - understand fully - or nearly there - red - not solid

clxxiv
## Multiplication and division

Write these addition sentences as multiplication sentences.
Write the answers.
Write a division sentence to check.

<p>| | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1. $q + q + q + q + q + q = $</td>
<td>6. $6 \times 12 = $</td>
</tr>
<tr>
<td></td>
<td>56</td>
</tr>
<tr>
<td></td>
<td>$59 \div 7 = 9 $</td>
</tr>
<tr>
<td>2. $7 + 7 + 7 + 7 + 7 + 7 + 7 = $</td>
<td>7. $4 \times 13 = $</td>
</tr>
<tr>
<td></td>
<td>46</td>
</tr>
<tr>
<td></td>
<td>$33 \times 7 = 7 $</td>
</tr>
<tr>
<td>3. $4 + 4 + 4 + 4 + 4 + 4 + 4 + 4 = $</td>
<td>8. $9 \times 15 = $</td>
</tr>
<tr>
<td></td>
<td>32</td>
</tr>
<tr>
<td></td>
<td>$22 \div 9 = 4 $</td>
</tr>
<tr>
<td>4. $8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 = $</td>
<td>9. $4 \times 18 = $</td>
</tr>
<tr>
<td></td>
<td>65</td>
</tr>
<tr>
<td></td>
<td>$80 \div 10 = 8 $</td>
</tr>
<tr>
<td>5. $6 + 6 + 6 + 6 + 6 + 6 + 6 + 6 = $</td>
<td>10. $6 \times 14 = $</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Multiplication and division

Write these addition sentences as multiplication sentences. Write the answers. Write a division sentence to check.

1. \(q + q + q + q + q + q + q = \) \(54\)

2. \(7 + 7 + 7 + 7 + 7 + 7 + 7 = \) \(49\)

3. \(4 + 4 + 4 + 4 + 4 + 4 + 4 + 4 = \) \(32\)

4. \(8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 + 8 = \) \(80\)

5. \(6 + 6 + 6 + 6 + 6 + 6 + 6 = \)

Write these multiplication sentences as addition sentences. Write the answers. Write a division sentence to check.

6. \(6 \times 12 = \) \(63\)

7. \(4 \times 13 = \) \(52\)

8. \(9 \times 15 = \)

9. \(4 \times 18 = \)

10. \(6 \times 14 = \)
Learning Intention:
To sort numbers and shapes using a venn diagram using 2 criteria
To understand that information can be sorted using different graphs and charts
To revise multiplication and division facts

Success Tips:
To sort 5 and 10 times table using a venn diagram
To sort 3 times table into tens and even numbers
To sort 2 times tables and even numbers
To sort shapes by colour and straight sides

Key words: chart lists, venn diagram, circles, interlock, overlap, intersection, multiples, criteria, sort
Key question: Why do you think information is collected and stored in this way

ICT: use of Coelho pp demonstrating how diagrams are used to sort information as an introduction for the children

Resources: pencils, worksheet, Labels for circles, large sheets

Context: Chn have completed a unit last term on the subject of handling data. Today I will be revising venn diagrams with year 4 and be introducing this way of recording information to the year 3.

Timing
9.30-9.35 Whole Class Teaching:
Introduction
Share the learning Intention

9.40 Mental/Oral

9.45 - 9.50
- Write a multiplication fact on the board ask chn to give me the corresponding division fact ie what is the inverse of 3x4=12 12÷3=4,
- Show fact triangles ask for chn to respond quickly
- Recap on previous work about bar graphs how they collected the information about different sweets
- Explain power point and discuss main features of a venn diagram.

Main Activity: (Includes differentiation)
- Write on the board/or prepare headings - multiples of 3 multiples of 2 up to 30
- Ask chn to list the two sets of numbers starting at 3 and ending with 30
- Ask are there any numbers that appear in both list? List under heading multiples in both lists
- Ask Are there any numbers that are not in the list
- Show chn a venn diagram and ask how could this information be represented on a venn diagram
- Which number would fit in the intersection?

Chn working in ability groups to complete task.

Group 1 working in groups of 3/4 chn complete the venn diagram representing multiples of 5 a number up to 50 chn record on sheet
Group 2 complete venn diagram with numbers that are have 3 tens and numbers that are even
Group 3 complete venn diagram with numbers that are have 2 tens and numbers that are even
Group 4 complete venn diagram sorting shapes in to straight sides curved sides

Groups 1 and 2 - one person to scribe list of numbers up to 50
Groups 3 and 4 working with support. Use large circles to record as a group before individual
<table>
<thead>
<tr>
<th>Time</th>
<th>Activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.20</td>
<td>Tidy &amp; Plenary</td>
</tr>
<tr>
<td></td>
<td>Ask chn to pose their questions and invite class responses. Discuss approaches to to the task. ie Refer back to learning intention - ask children how far they feel that they have achieved this. Children to vote - put up hands to 'traffic light' - eg green - understand fully - orange nearly th red - not solid.</td>
</tr>
</tbody>
</table>

**Extension**

Grp 1 - give chn set of shapes and a carroll diagram. Ask chn to make up own criteria for sc shapes  
Grp 2 - same activity as grp 1  
Grp 3/4 - Can they sort the shapes using a different criteria.

**Assessment Opportunities:** During input via questioning, during activity via children’s ideas, and in plenary via evaluation of pupils.

**Ability.** Grp 1 more able  
Grp 2 able  
Grp 3 average  
Grp 4 below average and SEN  
Chn on SEN - 1 statemented

**Learning Outcome:** All chn to sort and represent data in a venn diagram

**TA = Teaching Assistant**
WALT: To sort numbers in a Venn diagram

Multiples of 5

5  10  15  20  25  30  35  40  45

Multiples of 10

20  30  40
<table>
<thead>
<tr>
<th>X10</th>
<th>X5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Not 10x or</td>
<td></td>
</tr>
<tr>
<td>5x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>2 4 6 8 12 14 16 18</td>
</tr>
<tr>
<td>5 95</td>
<td></td>
</tr>
<tr>
<td>15</td>
<td></td>
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<td>85</td>
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<td>5x and</td>
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<td></td>
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<td>20</td>
<td></td>
</tr>
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<tr>
<td>40</td>
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</tr>
<tr>
<td>100</td>
<td></td>
</tr>
<tr>
<td>5 35 70 100</td>
<td></td>
</tr>
<tr>
<td>10 40 75</td>
<td></td>
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<tr>
<td>15 55 85</td>
<td></td>
</tr>
<tr>
<td>20 56 86</td>
<td></td>
</tr>
<tr>
<td>25 60 90</td>
<td></td>
</tr>
<tr>
<td>30 70 100</td>
<td></td>
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</tbody>
</table>
WALT: To sort numbers in a Venn diagram

Multiples of 5

Multiples of 10
LI: To sort numbers in a Venn diagram

- Even numbers
- Numbers with 3 tens

Set A: 30, 32, 34, 36, 38, 40, 96
Set B: 33, 34, 35, 36, 37, 38, 39
<table>
<thead>
<tr>
<th>Numbers bigger than 30</th>
<th>Numbers less than 30</th>
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</thead>
<tbody>
<tr>
<td>6, 30, 31, 32, 33, 34, 35, 36, 37, 38</td>
<td>8, 9, 20, 42, 50, 51</td>
</tr>
</tbody>
</table>

Match class: 3/9
LI: To sort numbers in a Venn diagram

Even numbers

Numbers with 3 tens
<table>
<thead>
<tr>
<th>Numbers less than 40</th>
<th>35</th>
</tr>
</thead>
<tbody>
<tr>
<td>Numbers bigger than 40</td>
<td>42 50 96</td>
</tr>
<tr>
<td>With 5</td>
<td>78 66</td>
</tr>
<tr>
<td>Without 5</td>
<td>5</td>
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Appendix U: Video clips evidencing total speech analysis
Glossary

ADHD  Attention Deficit Hyperactivity Disorder
AfL  Assessment for Learning
Becta  British Education Communication and Technology Agency
CGFS  Curriculum Guidance for the Foundation Stage
CPD  Continuing Professional Development
DfEE  Department for Education and Employment
DCSF  Department for Children, Schools and Families
DfES  Department for Education and Skills
ECM  Every Child Matters
GCSE  General Certificates in Secondary Education
HMI  Her Majesty’s Inspectorate
ICT  Information and Communication Technology
INSET  In-service Training
IRF  Initiation-Response-Feedback
IWB  Interactive Whiteboard
LAD  Language Acquisition Device
LEA  Local Education Authority
LNRP  Leverhulme Numeracy Research Project
MRI  Magnetic Resonance Imaging
NLS  The National Literacy Strategy
NNS  The National Numeracy Strategy
NQT  Newly Qualified Teacher
OECD  Organisation for Economic Co-operation and Development
OISE/UO  Ontario Institute for Studies in Education of the University of Ontario
Ofsted  Office for Standards in Education
PET  Positron Emission Tomography
PGCE  Post Graduate Certificate of Education
PIPS  Performance Indicators in Primary Schools
QCA  Qualifications and Curriculum Authority
QTS  Qualified Teacher Status
SATs  Standard Assessment Tests
SDP  School Development Plan
SEF  Self Evaluation Form
<table>
<thead>
<tr>
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<th>Description</th>
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<tr>
<td>SEN</td>
<td>Special Education Needs</td>
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<tr>
<td>SIP</td>
<td>School Improvement Partner</td>
</tr>
<tr>
<td>TTA</td>
<td>Teacher Training Agency</td>
</tr>
<tr>
<td>VAK</td>
<td>Visual, Auditory and Kinesthetic learning</td>
</tr>
<tr>
<td>ZPD</td>
<td>Zone of Proximal Development</td>
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References


Barth, H., La Mont, K., Lipton, J., and Spelke, E. S. (2005) ‘Abstract number and arithmetic in young children’, Proceedings of the National Academy of Sciences 102(39): 14117-14121.


